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WATER CONSERVATION, SOIL EROSION AND LAND USE

MAXIMUM economic production from the so-called marginal lands is much under discussion at the present time. Marginal land is generally assumed to be land which in the eyes of the planner of proper utilization is not producing some particular 'crop' or 'crops' up to its theoretical capacity. There have been frequent references in *Nature* during recent weeks to the need for better use of such land, and the attention of appropriate authorities in Great Britain has been directed at different times to the rival claims of hill farming, forestry, national parks, Nature reserves, and so on. A session at the recent Newcastle meeting of the British Association was devoted to the same topic (see *Nature*, October 15, p. 640).

Much of the marginal land in Britain is hill or mountain land, above the 600-ft. contour. This is the land which receives the highest rainfalls, from which most of the rivers flow, and from which many of the great cities of the country obtain their water supplies.

Although meteorological records of the amount of rain which falls on different parts of Great Britain are reasonably complete, we know very little about the behaviour of water *after it falls* on the land, whether it be on forest, moorland, grassland, cultivated land or other type of land surface. City dwellers read in a detached kind of way of an inch or more of rain falling in a day or part of a day in some hill country remote from centres of population; but few realize that 1 in. of rain falling on an acre represents 100 tons or 22,400 gallons of water. We do not know for British conditions how much of that water will run off immediately into the streams and the rivers if it falls on forest, grassland or arable land respectively, and how much will enter the ground. Yet every dweller in the hills and the mountain valleys knows that run-off is frequently rapid and excessive, that streams with quite small catchment areas swell into flood in a couple of hours and as quickly die down again—'flash floods' as the Americans call them.

Much of this excessive and rapid flooding would occur in any event, irrespective of the type of vegetative cover or land use. But probably the greater part of it is due to a complete neglect or lack of appreciation on the part of land users and planners of the principles of land hydrology in relation to land management. Schemes of afforestation, grassland improvement and land drainage are undertaken in hill and marginal lands with little regard to the bad or good results these measures may or may not have lower down in the same valley.

Closely linked with conservation and management of water is the world-wide problem of soil erosion. Many people would like to think that erosion does not occur in Great Britain, or that the damage caused is negligible and does not deserve serious consideration. Only rarely do we find the sensational gullying of other lands, although some of the ruin

left after war-time clear felling of forest land was just as serious. Our escape is due not so much to the types of soils in Britain or to superior methods of farming, as to the type of rainfall. The English drizzle and Scotch mist do not have the same erosive power as the torrential types of rainfall of high intensity/frequency against which special measures have to be taken in many other countries. In some of the agricultural areas of the United States of America, for example, they have to cater for intensities of more than 10 in. per day or 3 in. per hour.

British rainfall can, of course, produce gullying when it falls on sloping land unprotected by crops or adequate natural vegetation, as on the denuded area near the smelters at Landore, Swansea. British rainfall has, however, a much more widespread, insidious effect difficult to recognize until the eye is trained to note the symptoms. Slow, sheet erosion is very common in the hill lands of Britain, on both cultivated land and permanent pastures. It is not an exaggeration to say that most of the top-soil on sloping Welsh fields has over the years slipped gradually to the lower third of the field, and is prevented from going farther by the hedges which fortunately happen frequently to be laid out on the contour. On these sloping and on other generally undulating fields, the eroded areas are recognizable either by the type, depth or stony nature of the soil, or by the thin germination and early maturing of the crop, or by premature burning of parts of pastures in dry periods.

There is no need to make sweeping or sensational statements about erosion in Britain; it is, however, desirable that those concerned with land management should not close their eyes, but train them to recognize the symptoms and the degrees of damage. It would in many cases then be necessary to recommend the simpler conservation practices applicable to British conditions. These would include prohibition of ploughing on land likely to be seriously affected, the introduction of ploughing and cultivation on the contour, the planting of intertilled crops such as potatoes also on the contour, and the retention wherever possible of contour hedges, or pasture strips laid out on the contour. On many hilly areas, contour ploughing would be much more economical than up-and-downhill ploughing, which frequently entails going uphill empty and ploughing downhill only.

Much more important to the well-being of the British land is a wider appreciation of the relation between land management and the behaviour and control of the water which falls on, and flows out of, the hill lands of Britain. The present and apparently ever-increasing incidence of floods is one of the symptoms of lack of balance and proper control in the management of the hills and their waters, small or large. Nearly every winter or spring, the people of Shrewsbury and similar valley towns have to submit to flooded streets and houses; they look disconsolately to the west and wonder whether the people who live and work and use the land in the Berwyns or the upper reaches of the Severn can do anything to hold all this water back in the hills. But hill farmers and others who are responsible for using the land upon which most of the rain has fallen are actually doing everything possible to remove this water from their land as rapidly as possible. Reservoir authorities do wish to hold the water out of the rivers in their collecting basins, thus doing something to alleviate the problem of disposal of excess water; but most other persons and authorities take all possible steps to ensure that the excess flows to lower levels as rapidly and as soon after it has fallen as possible, often with little regard for the cumulative effects of such actions in the lower reaches.

Drainage schemes must necessarily play an important part in any development of marginal land for beef, crop and tree production, subjects very much in the public eye at the moment. According as these schemes progress, the hills will lose their capacity to act as a sponge, to absorb heavy rainfall, guide it into the ground-water reserves and control its reappearance over a long period of time in the form of springs. Before drainage, a so-called 'poor' section of hill land, of deep *Molinia* or *Sphagnum* bog, may be able to absorb anything from 75 to 100 per cent of the rain which falls upon it, except of course when it has reached saturation point after a long rainy period. When it has been drained, it may be able to retain only some 25 per cent of the rain that falls. Hence, if 100 acres are drained and 50 per cent of a day's rain runs off in a matter of hours, then since 1 in. of rain is equivalent to 100 tons of water per acre, 5,000 tons of water per 100 acres per day may be added to the flood peak, in the year following draining. Drainage of hill land is also necessarily practised in afforestation; but the increase in flood water is only temporary and falls again in a few years when the trees have become established and can contribute even more effectively to water conservation.

Anyone trained to appreciate the water-conserving capacity of different types of natural vegetation must feel concern at the almost universal desire to clear bog, bracken, scrub and other types of natural vegetation, and to replace these with 'improved' grasslands. Waste lands are not always completely useless, and sometimes the best way to use hill land is not to use it at all. In the absence of adequate data on run-off from different types of natural and sown or planted vegetation, it can only be surmised with reasonable certainty that much of this waste land has an important part to play in conserving water. It is questionable, for example, whether the Colesbourne land in the Cotswolds improved by Sir George Stapledon and his colleagues had after treatment as high a capacity to conserve water in the Thames catchment as it had when it was covered by scrub and matted herbage. This is a question which merits investigation in all hill improvement schemes.

The water régime in the hill lands is out of gear. Water rushes off in the winter, hills are bone dry in the summer, perennial streams have now become seasonal in flow, cottagers have to deepen their wells to reach the water, and all this in a land with a good rainfall. Great and expensive engineering works or the construction of storage reservoirs are not needed except for town water-supplies or hydro-electric

works. What are needed are the fundamental hydrological data to provide a basis for understanding the behaviour of water after it falls on hill land. The utilization and management of hill land could be adjusted for maximum conservation if we knew the comparative capacities of the various types of natural vegetation referred to above, if we would achieve some type of classification of slopes in relation to rainfall intensity/frequency and optimal land use on the American pattern. A great amount of information has been obtained on these aspects of land use in the United States; but it is not generally applicable other than in principle to British or other conditions. Each country must obtain data for its own types of vegetative covers and climates.

With a widely distributed network of standard run-off measurement plots on all the major soil and vegetative types of the country, it would be possible to amass data indispensable for planned land use in the hills. At present we have the meteorological data of the water just as it reaches the land, and presumably the major river authorities have records after it reaches the rivers, on such aspects as height and frequency of floods, silt loads and so on. Between these two stages, the sequence of knowledge is broken and quite inadequate, and yet the missing data would be of the greatest value. It would then be possible to state with reasonable accuracy for a particular catchment area what the effect on stream flow and seasonal availability of water would be if 1,000 acres of properly sited forest were planted, or alternatively if 1,000 acres of bracken were cleared and sown to a close-cropped grazing mixture. The vegetative cover of national parks could be kept at an ecological level most suitable to the dwellers alongside the waters which flow from the parks.

There is both a beauty and a purpose in natural unexploited vegetation, in the scrub and bracken-covered hillside, the bogs, moors and waste places. The waters flowing from them are in general clearer and more uniform in flow over the year than those from 'well-utilized' catchments. With a little more knowledge of land hydrology, we could probably evolve a greater and yet safer economic utilization of the hill lands of Britain, and at the same time improve the yielding capacity and economic value of the valley lands, at present exposed to the ever-recurring risk of damage from the waters which pour down upon them from the hills.

THE VEGETATION OF WESTERN NEW SOUTH WALES

The Vegetation and Pastures of Western New South Wales

With special reference to Soil Erosion. By Dr. N. C. W. Beadle. Pp. 281. (Sydney: Government Printer, 1948.) n.p.

THIS account of the vegetation of the western part of New South Wales deals with an area of some 150,000 square miles. In it are described the soils, the natural vegetation, the pasture lands and the effects of grazing, and soil erosion. The country is usually referred to as the "Western Plains" and is characterized by its flatness and the paucity of mountain ranges and hills. Four large streams, the Murray, Darling, Lachlan, and Murrumbigee Rivers, pass through the region. Practically the whole is covered by recent alluvial and detrital deposits of clays, sands, gypsum, etc. In the north-west the climate is of the desert type, while the greater part is classified as steppe type. Eastwards of the steppe climatic region and extending to the coast, outside the area under consideration, is the humid climate. Water supply is the main controlling factor in the distribution of the different types of vegetation.

Dr. Beadle classifies the plant communities essentially on a successional basis. Six plant formations are recognized: forest, woodland, mallee, scrub, saltbush, and grassland. Of forest, there are only small outliers of the dry sclerophyllous *Eucalyptus dealbata – E. sideroxylon* association with xerophytic shrubs and a poorly developed herbaceous layer. Three subformations of woodland, or communities dominated by trees in which the length of the bole is less than the depth of the crown, are accepted: tall woodland of the *Eucalyptus woollsiana* association, savannah woodland of five associations, and shrub woodland of two associations. Species of *Eucalyptus* and *Acacia* are the most important constituents; but sometimes *Callitris*, *Casuarina*, *Geijera*, *Flindersia*, *Eremophila*, and other genera are represented. The scrub formation is divided into three associations with acacias dominant in two and *Casuarina* and *Heterodendron* in the third. The saltbush formation includes all treeless areas dominated by low-growing perennial bushes of *Atriplex* or *Kochia*. The spaces between the bushes is occupied by annual or low perennial herbs and dwarf shrubs. In contrast, the treeless areas dominated by perennial grasses constitute the grassland formation with three associations named after the dominants: *Astrebla lappacea*, *Stipa aristiglumis*, and *Chloris-Danthonia*.

With few exceptions, the plant associations are not reliable indicators of the soil zones since they are determined primarily by rainfall. Yet soils are important in so far as they govern the amount of water available to the plant. Many species can tolerate, and flourish under, a wide range of conditions; but some are more confined and can be used, with care, as indicators of soil texture, soil reaction, or abnormal soil moisture.

Western New South Wales is, as a whole, a dry area; but wind is not the only agent in soil erosion. In spite of the low rainfall, water has been the agent in extensive sheet erosion and gullying. Extremely valuable accounts are given here of wind erosion (with scalding, formation of moving sand dunes, and occurrence of dust storms) and water erosion. It is definitely stated that the causes of all erosion in western New South Wales can be traced either to over-grazing by domestic stock and rabbits or to timber-removal, or to a combination of these two factors. The sheep is a selective grazer, and plants mostly disappear in order of their palatability—the palatable perennials first. It is possible by noting the occurrence and abundance of certain species to trace the stages in pasture degeneration. Drought is regarded as a secondary factor in erosion, accelerating it only where some primary factor has been operative.

A very full account is given of the five major formations noted above with discussion of the physical features of their ranges, their constituent species and their structure. Numerous photographs make up the bulk of 161 text figures. The succession within the

associations is considered and illustrated by diagrams. A list of references and an index are provided. A large coloured map, with the scale of 16 miles to one inch, shows the distribution of twenty-two plant communities (associations and associes). It was compiled by Dr. Beadle and is an impressive piece of work. One would like to know its degree of accuracy. The field and laboratory work took, it is stated, six years, and more than forty thousand miles were covered by car. The area of the survey is "some 150,000 square miles". On an average about seventy square miles must have been mapped every day. A general question may be asked about vegetation maps of this kind: would it not be much better to record on the map as accurately as possible the areas examined in some detail rather than to fill in the whole surface as if every square mile had been fully surveyed ecologically?

W. B. TURRILL

PARASITIC FUNGI

Les champignons parasites des plantes cultivées

Par Dr. G. Viennot-Bourgin. (Ouvrage publié avec le concours du Centre National de la Recherche scientifique.) Tome 1. Pp. xv + 756. Tome 2. Pp. 757–1,850. (Paris: Masson et Cie., 1949.) 2 vols., 6,000 francs.

OF these easily readable volumes one would need scarcely say any more than that the author deserves the highest praise and thanks of all mycologists and plant pathologists for assembling such a wealth of information about plant pathogens (bacteria and viruses are not included).

The treatment throughout the work is essentially systematic, and in the foreword one is immediately introduced to a classification of the fungi, which the author follows from beginning to end. (The nomenclature adopted is that of J. A. Stevenson, *Plant Disease Reporter*, 1944.) The whole work is therefore a standard reference to fungal parasites of plants, for those already equipped with a knowledge of the structure and functions of fungi in general. The author, in his preface, takes the view that a systematic treatment is preferable to one which describes the parasites under the common host attacked, but, he adds, he does not hesitate to supplement bare taxonomy when any species deserves amplification on economic or other grounds. Indeed, the lavish way in which the author has drawn upon biological researches accounts largely for the great size of the work.

For the more important parasites, in all sections of the work, the reader is given details relating to synonymy, history, geographical distribution, hosts, symptoms, morbid anatomy, influence of external factors, etc., and methods of disease control. The volumes are fully illustrated by line drawings beautifully executed, those of the spores being particularly helpful in all the sections; the reproduction of the half-tone photographs appears to suffer somewhat from the inferior quality of the paper employed.

The first volume of 756 pages treats of some 280 parasites from the Myxomycetes, Archimycetes, Siphomycetes (Phycomycetes), and Ascomycetes. *Plasmodiophora brassicæ* is covered in ten pages with four figures. In the Archimycetes, twelve pages with five figures are devoted to *Synchytrium endobioticum*; here, it is difficult to see on what grounds the resting sporangium is called a zygosporangium, and with the omission of line-drawings it is not easy to follow the life-history of this organism. The Peronosporales are treated at great length. Prefaced by a generous introductory account, this group is divided into Pythiaceæ, Albuginaceæ and Peronosporaceæ. In the last-named family detailed treatment is given to *Phytophthora infestans* and *Plasmopara viticola*. The former, embracing twenty-nine pages with eight figures, describes the blight on both potato and tomato. Here the author makes far more use of the term 'conidium' than of 'sporangium' in this group, despite the generally accepted view that the asexually produced spore in the Peronosporaceæ is potentially a sporangium. Haustoria in *P. infestans* are described as "rudimentary" or "very small and nodular", the latter being probably descriptive of the encapsuled kind often found in tubers more or less resistant to blight. In relation to this disease the author does not refer to Müller's important work (1940), where a rapid necrotic reaction, with no formation of haustoria, is described as occurring in tubers strongly resistant to infection. In all, nine species of *Phytophthora* are described. It was only natural that *Plasmopara viticola*, the well-known parasite of the grape vine in France, should compete so closely with *P. infestans*, for twenty-two pages with twelve figures are devoted to it. (Other parasites of the vine are also generously treated in their appropriate sections.) In the Ascomycetes, after relatively brief comments on the Protomycetales and Saccharomycetales, lengthy accounts are given of numerous genera in this big group, notably *Taphrina*, *Ceratostomella*, *Nectria*, *Gibberella*, *Mycosphærella* (*M. pinodes* is given as the perfect form of *Ascochyta pisi*), *Claviceps* (fifty-eight hosts are cited), etc. *Venturia inæqualis*, the parasite of 'apple scab', is most comprehensively treated in twenty-eight pages with twelve figures. The cognate species *V. pirina* has, as its conidial form, the unfamiliar designation of *Megacladosporium pirinum*. *Ophiobolus cariceti*, described as the organism "contributing to the 'take-all' disease of cereals in America", includes *O. graminis* as a synonym. One would have wished for a wider treatment than is given here of this important disease, in view of extensive investigations devoted to it. Three *Pyrenophora* (*Helminthosporium*) types attacking cereals are also somewhat briefly treated, and one gets the impression that the cereal parasites have been relatively meagrely treated, though by no means inadequately, in this volume. Two types of *Glomerella* are described, the one causing 'anthracnose' of the haricot bean being designated *G. lindemuthianum*, despite the uncertainty of its being the 'perfect' form of *Colletotrichum*. An excellent exposition of the *Sclerotinia* group brings the first volume to a close, the whole covering sixty-six pages, no fewer than twenty-one species being described.

The second and larger but less important volume, of some eight hundred pages, is devoted to the Basidiomycetes (500 pp.) and the Fungi Imperfecti (300 pp.). Following an excellent introduction to the biology of the 'smut fungi', twenty species of *Ustilago* are described, the most detailed being *U. tritici*, *U. kolleri* and *U. zeæ*. *Tilletia caries* occupies twenty-seven pages, and four other species of that genus are also described. The 'rust fungi', again, are treated in excellent style, sixty pages being devoted to a general account of this important group. All the genera are fully treated; twenty-three species of *Puccinia* are described, *P. graminis* occupying thirty-one pages with numerous illustrations. In the group Auricu-

lariales, more than a hundred hosts are listed for *Helicobasidium purpureum* or its sterile *Rhizoctonia*-form. In the Aphyllophorales, *Corticium solani* is fully treated, but the group *Stereum* is relatively briefly dealt with, as are also many of the parasites of standing timber. Two species of *Polyporus*, *P. sulphureus* and *P. coffeæ*, are described, other common polyporous species being hidden under such unfamiliar names as *Melanopus*, *Phæolus*, *Leptoporus*, *Xanthochrous*, etc. In the Agaricales, *Armillaria mellea* is fully described. The detailed treatment given to selected parasites in the Fungi Imperfecti will be greatly welcomed by all.

A bibliography of more than five thousand titles and a double-column index of seventy-five pages are appended. The volumes (bound in most austere fashion in stiff paper, with uncut sheets) are prefaced by a note written by Prof. Roger Heim, who pays Dr. Viennot-Bourgin a well-deserved tribute for an excellent and comprehensive work, with which the reviewer agrees.

S. G. JONES

PHILOSOPHY FOR LAY FOLK

Plato's Life and Thought, with a translation of the Seventh Letter

By R. S. Bluck. Pp. 200. (London: Routledge and Kegan Paul, Ltd., 1949.) 8*s*. 6*d*. net.

Philosophy for Pleasure

By Hector Hawton. Pp. x+214. (London: Watts and Co., Ltd., 1949.) 10*s*. 6*d*. net.

Foundations of Philosophy

By T. V. Fleming. Pp. x+210. (Sydney and London: Shakespeare Head Press Pty., Ltd., 1949.) 15*s*.

THE amateur is a little out of fashion just now; nevertheless, he is by definition a lover, and therefore presumably entitled to occupy a niche in the ever-growing edifice of philosophy. These three books differ both in the subject-matter which they present and in the method of presenting it. But it is legitimate to group them together because they all profess to be readable guides to great matters, for the benefit of the non-expert.

Mr. R. S. Bluck's little volume is the most serious and scholarly of the three; he handles the familiar theme of Plato's life with a certain indefinable freshness which will attract people and retain their attention. The atmosphere of the Academy—so far as it is possible to recapture it and to inhale its essence at this time of day—is exceptionally well portrayed, and with it the master's predilection for the study of factual truth, as achieved by the method of dialectic. The main item, however, is the translation of Plato's "Seventh Letter". The author offers this important piece of work of his own, with careful notes where he diverges appreciably from the Oxford text of Burnet. Alone among authorities, Prof. Cherniss rejects this Letter, as he does Letter 1, in company with practically all the chief commentators.

The attractive small book by Mr. Hector Hawton is quite openly an attempt to make people like philosophy, and absorb a considerable dose of historical and epistemological learning with a minimum output of tears. Indeed, the author seems to have achieved his object, well and truly. Examples are the chapters dealing with the revolt against metaphysics and the return of this discipline. There are one or two blemishes, where sweeping short statements might suggest that the writer too readily dismisses views he happens to dislike; but a careful reading goes some way towards maintaining confidence in the general impartiality of approach. There are several very telling remarks, for example, "Logic does not reveal new facts. Hegel thought it did . . ."; and this is part of a chapter giving an excellent account of the new logic, the essence of the propositional calculus, and the algebra of relations. At the end is a useful glossary, not always completely watertight, but once again encouraging to those out to enjoy themselves.

With the third book, that by Fr. T. V. Fleming, we are on rather different ground. The author, almost deliberately it would seem, gets started on the wrong foot by calling his book "Foundations of Philosophy" and yet, on his own showing, submitting a very able account of the *philosophia perennis* with just a few extracts from other systems thrown in. This unfortunate lack of balance is accentuated by the way in which the ethical issues are presented. They invite the critics to dismiss them as special pleading. In addition, the writer's habit of quoting short sentences, completely out of their context, by well-known authorities, and then saying in effect "Q.E.D.", adds to the general sense of discomfort. All this is a pity, for Fr. Fleming is obviously a very capable expositor, and much of what he discusses is of interest. A much wider view, and a much broader base, for "Foundations" are prerequisites if this manual is to command the respect one would wish it to enjoy.

F. I. G. RAWLINS

MATHEMATICS FOR ELECTRICAL AND TELECOMMUNICATIONS ENGINEERS

Compléments de mathématiques à l'usage des ingénieurs de l'électrotechnique et des télécommunications

Par Prof. André Angot. (Collection technique du C.N.E.T.) Pp. vii+660. (Paris: Éditions de la Revue d'Optique, 1949.) n.p.

AT present there is often very imperfect collaboration between the pure mathematician interested in such subjects as matrices, tensors and rigorous analysis of functions of the complex variable on one hand, and on the other the practical man who has a sort of intuitive instinct for finding out the causes of failure in radio or mechanical apparatus, but is likely to regard advanced pure mathematics as a kind of black magic.

In fact, if the mathematician and the practical man could only find a common language, there is a vast territory in which it could be used with mutual advantage. Col. André Angot's book provides both such a common language and a map of the outstanding features of the territory. The pure mathematician is shown the relevance to electrical and telecommunication technique of the abstruse processes with which he is familiar, while at the same time the practical man is shown the fundamental basis of familiar practical results. Rigour has been deliberately sacrificed in order to get within one volume information hitherto scattered in many different books and periodicals, in several languages. Nevertheless, all the subjects covered are discussed *ab initio*. Important results are stated and their sequence is indicated. Proofs are often summarized

or omitted; bibliographies are given at the ends of several chapters in which such proofs can be found. The typography and diagrams are excellent; few misprints are to be found.

Chapter 1 deals with complex variable theory, including integration by the residue method and conformal transformations. In Chapter 2, Fourier series and integrals, and their application to electric circuits, are discussed. Chapter 3 covers vectors, vector products, divergence, curl, gradient, and scalar and vector potential. Matrices are discussed in Chapter 4, with applications to the theory of quadripoles and specific examples, to the solution of algebraic equations, and to the determination of free oscillations of networks. In Chapter 5, tensors and curvilinear co-ordinates and their applications are considered, with particular reference to crystals and other anisotropic media. Chapter 6 deals with methods, including approximation methods, for solving ordinary and partial differential equations. Chapter 7 has separate sections dealing with hyperbolic functions, sine and cosine integral functions, the error functions and Legendre functions. Chapter 8 deals with operational calculus; applications to the solution of differential and integral equations as well as to electrical problems are considered. Chapter 9 deals with the theory of probability, and includes a section edited by M. Blanc-Lapierre on aleatory functions. Applications to errors of measurement and the method of least squares are discussed.

Many will have more than sufficient mathematical ability to understand the parts of this book relevant to their work. For such people the fundamental groundwork has been covered for an amazingly large number of topics, with full discussion of appropriate numerical examples. Once the reader has mastered this fundamental groundwork, he is provided with sufficient knowledge for making further progress by himself. The book can therefore be thoroughly recommended both as a text-book and especially as a reference book that will be needed continually by the practical man. J. W. HEAD

RADAR FOR STUDENTS

A Textbook of Radar

A Collective Work by the Staff of the Radiophysics Laboratory, Council for Scientific and Industrial Research, Australia. Pp. viii + 579 + 31 plates. (London: Chapman and Hall, Ltd., 1948.) 50*s*. net.

THE active development of radar dates from about 1935, and until about 1941 most of the important work was done in Great Britain. After 1941 the contributions to Allied radar equipment made by the United States, Canada and Australia increased, until eventually the contributions of the United States alone outstripped those of Britain. The work in Australia was carried out by the Radiophysics Laboratory of the Council for Scientific and Industrial Research in co-operation with industry. This Laboratory was established in 1939, and although small in comparison with those in the United States and in Great Britain, it made significant contributions to Allied equipment. For example, the service in the Pacific of the Australian air-warning radar, Type *LW/AW*, bears witness to the value of its work.

"A Textbook of Radar" is a collective work by the staff of the Radiophysics Laboratory, and it is a synthesis of the subject as seen in about 1946. The book contains twenty chapters, thirty-one plates and an index. The text is admirably illustrated by diagrams and photographs, and is well printed and free from errors.

The first chapter is an introduction, which is mostly historical. The second is called "Fundamentals", and deals with the basic principles and equations which govern a radar system, together with a discussion of propagation. The next thirteen chapters form three-quarters of the book and deal with the components. They discuss the magnetron, the pulsed operation of triode power oscillators, pulse modulators, microwave transmission and cavity resonators, aerials and aerial duplexing, receivers and their associated oscillators and mixers, display circuits and automatic ranging circuits. These thirteen chapters are contributed by twelve different authors. The next four chapters discuss the application of radar systems to uses on land, at sea and in the air. The final chapter deals with navigation.

A text-book such as this must balance three main elements, the history, the problems of radar systems viewed as a whole, and the discussion of instrumental techniques. A proper balance is made difficult by the rapid, recent and largely secret development of the subject. This book achieves a fairly good balance; however, the lapse of three years and the appearance of specialized volumes on technique suggest that more space might well have been given to the fundamentals of radar systems at the expense of the discussion of technique.

The historical element in the book is excellent and is largely contributed by Dr. E. G. Bowen, who is well known as an original member of Sir Robert Watson-Watt's pioneer team. It is gratifying, in view of the usual exclusive importance given to microwaves, to find an adequate place given to the contribution of 'metre-wave' radar to the War.

The chapters dealing with technique leave 'metre-wave' problems to other works and concentrate on microwaves. They are clear, fundamental and of sufficiently high standard to be valuable to advanced students and to radar workers. With so many authors, the breadth and depth of treatment varies, and one could comment and criticize many points. For example, the treatment of cavity resonators and of the transient response of receivers are both lengthy and well illustrated. On the other hand, radomes are not dealt with, and angle data transmission systems get only glancing references.

The chapter on "Fundamentals" by J. L. Pawsey is excellent and might well have been expanded. The remaining chapters on radar systems and on navigation are very condensed. The one dealing with ground radar is well illustrated and interesting. It omits, however, mention of moving-target indicators, presumably because of secrecy at the time of writing, and also fails to discuss adequately the very important subject of how ground radar information is displayed and used. The chapter on navigation is parochial in its treatment of civil aviation and gives an interesting description of some Australian equipments. It fails to give adequate space to the application of radar to the merchant marine.

Nevertheless, as a single volume on the subject for the advanced student, research worker or practising engineer, this book has few competitors. In a larger library on radar and electronics it will be valued, not only as a text-book, but also as another account of radar from one of the war-time Allied laboratories.

R. HANBURY BROWN

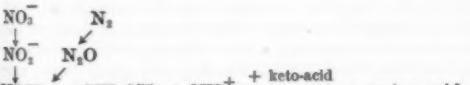
THE NITROGEN CYCLE IN NATURE

ON September 2, at the recent British Association meeting in Newcastle, a discussion was held by Section B (Chemistry) on "The Nitrogen Cycle in Nature". Prof. G. R. Clemo, in introducing the discussion, gave a general survey of the great importance of the nitrogen cycle in Nature, which ensures that, unlike other natural resources generally, our vast reserves of atmospheric nitrogen are never likely to become exhausted. Among the many groups of naturally occurring nitrogenous substances, he made special mention of chloromycetin, the first organic nitro compound to be discovered in Nature and containing the fundamental C_6C_2 unit characteristic of many plant products.

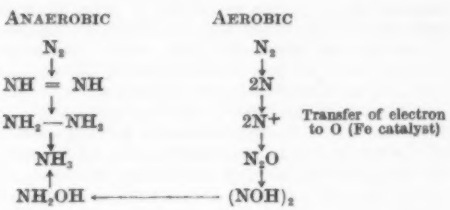
Robinson's earlier ideas on the biogenesis of alkaloids have recently been followed up, leading to new ideas on the structure of emetine and to the synthesis under physiological conditions of sparteine by Anet, Hughes and Ritchie of Sydney. Prof. Clemo also made reference to possible future developments, including work on bee venom, which is stated to contain a specific protein or proteins and to have a bearing on rheumatic diseases.

Prof. A. I. Virtanen gave an account of the work being carried out at Helsinki by himself and his collaborators on the utilization of the nitrate ion by plants and its relation to the assimilation of the ammonium ion and molecular nitrogen. For an understanding of the mechanism of the assimilation of nitrogen, one of the important questions is whether nitrate is reduced to ammonia or whether ammonia is the central nitrogenous compound which is produced from all nitrogen sources (including molecular nitrogen) before amino-acid synthesis. The one observation against this thesis is the formation of oxime nitrogen; its mode of formation is therefore a problem of great interest. A simple chemical explanation of α-amino-acid formation might, of course, be the action of hydroxylamine on α-keto-acids, if the former were, in fact, present.

With *Torula*, it has been shown that oxime nitrogen arises from nitrate in strongly aerated solutions, very rapidly reaching the maximum within 10–15 min. and then diminishing. In a corresponding experiment, ammonium nitrogen does not yield oxime nitrogen. Similarly, Virtanen and Jarvinen have shown that, in comparable experiments, *Azotobacter* produces oxime nitrogen more rapidly from molecular nitrogen and from nitrate nitrogen (about 1–2 hr. in each case to obtain a detectable amount of oxime) than from ammonium nitrogen (3 hr.), although in the latter case the induction period is absent. These results suggest that, both in the reduction of nitrate and in the fixation of molecular nitrogen, oxime nitrogen is formed before ammonia, rather than after it, although the reduction to ammonia is probably the main process:



In anaerobic nitrogen fixation by *Clostridium*, Virtanen and Hakala failed to detect any traces of oxime nitrogen. The anaerobic nitrogen fixation is most likely to proceed via reduction (cf. Wieland). In the aerobic nitrogen fixation a primary oxidation of nitrogen is possible. From the $(NOH)_2$ stage onwards, reduction of nitrate and fixation of molecular nitrogen would then follow the same path.



The postulation of these two different routes is not attractive but, at present, seems unavoidable. All the results so far obtained imply that all nitrogen sources produce chiefly ammonium nitrogen prior to amino-acid synthesis; but that hydroxylamine, which is formed in nitrate reduction and in aerobic nitrogen fixation, yields also small amounts of oxime nitrogen. The cells ought, therefore, also to have an enzyme system to catalyse the latter route. Oxidation of ammonium nitrogen leads likewise to oxime nitrogen.

Nitrate reduction has generally been noted to be sensitive to cyanide, and hence a heavy metal would be an essential factor in the enzyme system. Warburg first suggested that the metal might be iron; but later Burstrom thought manganese more likely. Molybdenum, too, seems to be indispensable in the assimilation of nitrate as well as, according to Mulder, that of molecular nitrogen. Wirth and Nord have found that nitrate reduction with *Fusarium* is not sensitive to cyanide, and hence nitrate reduction can be brought about by different enzyme systems.

Finally, Prof. Virtanen described a recent extension which follows on from work he had done before the War on the growth of green plants (for example, peas) from seeds the cotyledons of which had been removed. In these experiments, nitrate was used as the nitrogen source, and it was shown that addition of ascorbic acid could restore normal growth (the ascorbic acid of pea seeds is normally found mainly in the cotyledons). It is now found that for growth on media containing ammonia no ascorbic acid is needed—in fact, if added, it actually retards the growth. Similar results have been obtained with endosperm-free wheat germs. That the effect (for growth on nitrate) is not specific for ascorbic acid but is, in fact, brought about by other reducing substances (for example, sodium sulphide, cysteine, glutathione, reductone) has been shown by Virtanen and Saubert-v. Hausen. Although Karrer has shown that ascorbic acid will reduce nitrite in boiling solution, this requires an acid solution and is unlikely to occur in the plant cell at *p*H 6, and, moreover, no accumulation of nitrite has been observed in the cotyledonless plants. Thus, the effect of these substances is not based on their ability to reduce nitrate, but is associated with the function of the nitrate-reducing enzyme system.

Dr. G. R. Tristram then dealt with the work of Chibnall, Vickery and other workers on the amino-acid/protein aspect of the nitrogen cycle. Within the main nitrogen cycle there is another cycle involving a turnover between protein, amino-acid and ammonia, and it is important to realize that this cycle does not operate merely as more protein is required but that there is a continuous elaboration and breakdown of protein. The problem discussed was the mechanism by which nitrogen and various carbon skeletons are united with the ultimate formation of protein.

Whether or not the amino-acids are the actual intermediates in the synthesis of protein, it is now well established that the dicarboxylic amino-acids, glutamic and aspartic acids, and their respective amides, are the key compounds in its elaboration, not only as a ready source of amino-groups, but also, in the case of glutamic acid, as a source of a carbon skeleton. Dr. Tristram stressed the interconversion of carbon skeletons as a mechanism for the synthesis of amino-acids, as well as merely the donation of amino-groups on to a carbon skeleton from another source. In addition, both these amino-acids and alanine provide a connexion with carbohydrate metabolism. That glutamic acid is the first product synthesized in the assimilation of ammonia or nitrate was shown by Burris and Wilson by experiments in which $N^{15}H_3$ was fed to certain micro-organisms. Amino-acids may arise in a number of different ways, for example, by the amination of carbonyl compounds (for example, keto-acids) with ammonia or hydroxylamine, by the addition of ammonia to unsaturated acids, such as fumaric acid, or by transamination, in which case the amino-group is transferred from an amino-dicarboxylic acid to a keto-acid. The latter was originally thought to be a general reaction involving glutamic acid and the keto analogue of any amino-acid. It is now known that it is relatively restricted as a fast reaction involving glutamic acid, oxalacetic acid and pyruvic acid. Glutamic acid, plus ammonia, is converted into its amide with the aid of adenosine triphosphate. There is no evidence to show that glutamine and asparagine are synthesized by glutaminase and asparaginase working in reverse. The mechanism of asparagine synthesis is not known.

One role of the amidases is to store, in non-toxic form, the ammonia which is liberated on protein breakdown, and thus to conserve nitrogen. One fact which emerges from the vast amount of work on amide synthesis in plant tissue is that glutamine is always present, although sometimes in very small amount, whereas asparagine may be completely absent. This may mean that glutamine is more important as an intermediary than is asparagine, which would function merely as a store of amino-groups.

The fact that the keto analogues of certain of the so-called essential amino-acids are effective for growth in animals suggests that their carbon skeletons might be the parts of the molecule which cannot be synthesized. Using an analogy from animal work, Chibnall put forward the view that these carbon skeletons might well arise from the organic acids some of which take part in the Krebs cycle, suggesting a close link with carbohydrate metabolism. Nevertheless, the origin of the carbon skeletons of valine, leucine, *iso*leucine, tyrosine and phenylalanine is still to be explained.

As to the mode of protein synthesis, many theories have been advanced. Although protein synthesis may well involve the preliminary formation of amino-acids followed by their condensation into peptide linkages, there is no conclusive evidence that protein synthesis is, in fact, the reverse of proteolysis. Dr. Tristram then outlined the theories of du Vigneaud, Linderstrøm-Lang and Bergmann and Fruton, and pointed out that they lacked experimental evidence to support them. He suggested that it is possible that there are several different mechanisms for peptide formation of the various amino-acids (for example, lysine in animals must be fed as such, but methionine can be fed as the keto analogue).

Consequently it is possible that peptide synthesis involving methionine keto-acid may be different from a synthesis involving lysine. Dr. Tristram then pointed out the view of himself and Mr. Hird that it may be possible that the keto analogue is aminated and coupled in a single stage to form a peptide linkage with the aid of a labile amino-donating group and phosphate energy. This could account for the amination of amino-acids which do not appear to participate in transamination.

In the succeeding paper, Prof. J. H. Quastel dealt with the effects of organic nitrogen compounds (especially amino-acids) on soil nitrification, as studied by the use of his own simple and elegant soil perfusion technique, a brief account of which was given. The bearing of hydrogen ion concentration on the process of nitrification was discussed, and it was shown that organic molecules which yield ammonia are more readily nitrified by an acid soil than are the inorganic ammonium salts. Similarly, non-nitrogenous organic molecules which yield bicarbonate as a product of their metabolism assist nitrification in acid soils. On neutral or alkaline soils the inorganic ammonium salts are nitrified a little more readily than are the amino-acids.

All the amino-acids studied nitrify readily, with the striking exception of methionine. If methionine is mixed with ammonium chloride, nitrification is retarded for sixteen days, and then suddenly both are nitrified very rapidly. This is the only known naturally occurring nitrogen compound which inhibits nitrification. It also delays the conversion of nitrite to nitrate for ten days; but the methionine is itself in this case unattacked, indicating that the organisms have developed a tolerance. The presence of the amino-acid in proteins and protein decomposition products may account, partly at any rate, for the inhibitory action of these substances on nitrification. The amino-acids studied do not yield all their nitrogen in the form of nitrate; the yield is inversely proportional to the carbon/nitrogen ratio of the amino-acid. But they do not, with the exception of methionine, inhibit the nitrification of ammonium ions. The mechanism of action of methionine may give a clue to the manner in which ammonia undergoes metabolism in nitrifying cells.

Thiourea also inhibits nitrification of ammonia, even at as low a concentration as 0·0003 *M*, for at least sixteen days. Ethyl urethane (0·01 *M*) inhibits nitrification for about three weeks and then is itself nitrified through the development of a special urethane-metabolizing organism. These substances presumably interfere in some way with some aspect of ammonia metabolism, and it is interesting to note that they are both carcinogens. The metabolism of enriched soil has also been investigated in the Warburg apparatus; the rate of oxygen uptake using ammonium chloride is linear; and thiourea lowers

the rate, but a much higher concentration is here needed.

Lastly, Prof. Quastel discussed his work on the metabolism of pyruvic oxime. This is nitrified very rapidly in soil into nitrite and nitrate. The effect can readily be demonstrated by the addition to enriched soil first of hydroxylamine, which is toxic; but on the subsequent addition of pyruvic acid, rapid nitrification ensues. Other oximes (except that of oxalacetic acid) do not show comparable effects. Also, methionine is without effect, showing that this direct conversion of pyruvic oxime into nitrite is not accomplished by *Nitrosomonas* or *Nitrobacter* but by a class of heterotrophic soil organisms which have been isolated. This result shows that nitrification in soil may not be accomplished wholly by the well-known autotrophic organisms but that heterotrophic organisms may play a part in the direct nitrification of an organic nitrogen molecule, although there is, as yet, no proof that pyruvic oxime is a normal metabolic product under soil conditions.

The concluding paper was read by Dr. E. J. Hewitt and was concerned with the importance of molybdenum in the nitrogen cycle—a subject already touched upon by Prof. Virtanen—which is being studied at Long Ashton. Molybdenum is of widespread significance in the plant kingdom. It is needed in certain circumstances by free and symbiotic nitrogen-fixing and denitrifying organisms, by fungi and by representatives of at least ten families of higher plants. The minute amounts of molybdenum needed have rendered progress slow, until recently, when special techniques have been devised. Deficiency and excess symptoms in higher plants suggest that molybdenum influences nitrogen metabolism, meristematic development and water relations. *Brassica* types especially and tomato and clovers seem to be particularly susceptible. Molybdenum is essential for *Azotobacter* and *Rhizobium* when fixing nitrogen. It is also needed by higher plants and by *Aspergillus niger*, denitrifying bacteria and *Azotobacter* when supplied with nitrate nitrogen, but apparently it is not needed at all (or at greatly reduced levels) when nitrogen is given as ammonia or urea. When molybdenum is lacking, nitrate accumulates or persists and is not reduced. Vanadium can replace molybdenum at a low level of efficiency in *Azotobacter*, but not in *Rhizobium* or in the metabolism of fungi and higher plants. The precise step in reduction of nitrogen compounds catalysed by molybdenum is still obscure.

Manganese is also essential for nitrogen assimilation, since nitrate accumulates when manganese is deficient. Manganese, however, has an opposite effect on amino-acid concentration; but the effects due to its deficiency are also partly dependent on the source of nitrogen.

Soil fertility may be influenced by the availability of the molybdenum. This element is less available in acid soils, and such soils are frequently deficient in available nitrogen. Failures in the establishment of subterranean clovers and other legumes in poor acid pastures of South Australia have been traced to unavailability of molybdenum for the root nodule organisms. Such pastures appear nitrogen-deficient, and beneficial results are obtained by application either of large amounts of sodium nitrate or as little as a quarter of an ounce per acre of sodium molybdate. As clovers given nitrate nitrogen in culture experiments still require molybdenum, it is evident that when given sodium nitrate in soil there is sufficient molybdenum for the requirements of the plant, although not enough for those of the root nodule bacteria. In spite of this differential effect on clovers, *Brassica* types may still suffer from molybdenum deficiency in the field; and the condition long known as 'whiptail' in broccoli and cauliflower may be related to molybdenum deficiency and has been reproduced experimentally in sand cultures by omitting molybdenum. Liming greatly increases the availability of molybdenum; its effect may be on *p*H directly or on reducing the availability of manganese (the two elements apparently being antagonistic).

Molybdenum is thus important in three aspects of the nitrogen cycle, namely, fixation, assimilation from nitrate and denitrification; but in all a reduction process seems to be involved.

Following the reading of the papers, a discussion took place during the afternoon, which emphasized the very incomplete present-day state of knowledge of the chemical reactions underlying the nitrogen cycle.

G. R. Clemo
G. A. Swan

CONSERVATION AND UTILIZATION OF WORLD RESOURCES

UNITED NATIONS CONFERENCE

DURING the period August 17–September 6, the United Nations Scientific Conference on the Conservation and Utilization of Resources, convened by the Social and Economic Council, was held at Lake Success, New York. Its deliberations covered a very wide field, in that they dealt with the conservation and utilization of the principal resources affecting human life throughout the world, namely, minerals, fuels and energy, water, forests and land. The Conference was attended by 535 delegates from forty-nine nations, which included various Eastern European countries but not the U.S.S.R.

The Conference was the first one on world conservation ever to be held. It was a first step by the United Nations towards mobilizing the science of the whole world to promote higher standards of living, and towards implementing the programme of technical assistance to under-developed countries which the United Nations Organisation is undertaking. By such means, it is hoped to bring into sustained use resources as yet untapped and to build up more productive and diversified economics. Stress was laid on the part to be played by major concerted undertakings wherever possible.

The Conference was scientific rather than policy-making. It had no power to bind governments, and did not formulate recommendations to them, nor did it attempt to reach international agreements on policies; its task was limited to the exchange of experiences on the techniques of the conservation and utilization of resources. In the course of discussions, however, both formal and informal, questions of policy inevitably crept in, since it is practically impossible to consider the broader problems of conservation separately from those of control. It was generally conceded that in the more compre-

hensive programmes at least some basic government assistance or direction is essential.

The first two days of the Conference were devoted to plenary meetings; addresses of welcome were given by Mr. J. A. Krug, Secretary of the Department of the Interior, United States, who expressed the readiness of his Government to assist in the advancement of the less developed countries, and by Mr. A. Trygve Lie, Secretary-General of the United Nations. There followed addresses on the world resources situation by Fairfield Osborn and Colin G. Clark; and reviews of critical world shortages in the fields of food, forests, minerals and fuels, and energy were given respectively by Sir Herbert Broadley, Marcel Lelrup, H. L. Keenleyside and John C. Parker. The interdependence of resources was considered by various speakers, including Emmanuel de Martonne, Ernest Weissman and L. Dudley Stamp.

During the main period of the Conference the meetings of the various Sections—Minerals, Fuels and Energy, Water, Forests, Land—were held in the mornings, while the afternoons were given to plenary meetings in which symposia and discussions on interrelated problems were held. The subjects discussed in the plenary meetings included soil and forest conservation and the protection of water supplies, estimates of undiscovered oil and gas reserves, metals in relation to living standards, creatable resources, resource surveys, education for conservation, and resource techniques for less developed countries.

The last two days were devoted to plenary meetings in which were discussed the integrated development of river basins, with special reference to the experience of the Tennessee Valley Authority, and public policy. The work of the sections was reviewed by various speakers; and at the concluding session an address on the use of resources for the enrichment of human life was given by Vijaya Lakshmi Pandit, Indian ambassador to the United States, and one, on the contribution of the Conference to the continuing work of the United Nations, by James Thorne, president of the Economic and Social Council of the United Nations.

Minerals Section

Turning now to a more detailed consideration of the Minerals Section of the Conference, it may be said that in this, as in other Sections, there was presented a most valuable series of papers in which were reviewed recent advances over a very wide field, including theory and technology, estimates of reserves, outlook for future discovery, geographical factors in development, conservation in mining and in manufacture, and conservation by corrosion control and by substitution. The papers and the discussions on them are to be published in due course; but unproofed copies of the papers were available at the conference to all participating delegates.

In the course of the opening plenary meetings, H. L. Keenleyside presented a paper on critical mineral shortages, in which he came to the conclusion that while there are in the world to-day no mineral shortages which are critical, this temporary condition should not be allowed to introduce a false optimism as to the future.

The first topic discussed in the meetings of the Minerals Section was the estimate of selected world mineral supplies by cost range, to which papers were contributed by Elmer H. Pehrson and A. M. P. Légendre. The former gave a series of tables of great interest, including estimates of the world production and reserves of the principal minerals, the *per capita* consumption of selected metals and minerals in the United States and other areas, showing relatively extraordinarily high consumption in the United States, and the world reserves in years of supply at the American and other rates. The geographical factors in mineral development were discussed by Alan M. Bateman and other authors.

The topics of increasing mineral resources by discovery and of the possibilities and costs of methods of discovery attracted papers by many authors on mineral discovery and on prospecting methods in many parts of the world, including North America, Canada, Sweden, India, Liberia, Cuba and Latin America.

A symposium was held on the outlook for future discovery. In an introductory paper, F. Dixey showed that, in view of the very active interest now being taken in mineral prospecting throughout the world, and in spite of the probability that all or most of the major mineral fields are already known, there is good prospect of the discovery within the next few years of some important deposits and of numerous medium and smaller deposits that will be of value for local purposes and for export. He referred also to the prospects of mineral discovery in the British Colonies.

In a paper on the outlook for mineral discovery in Great Britain, W. F. P. McLintock showed that in a well-developed country such as Great Britain, where geological knowledge is at a satisfactory level, the discovery and development of new deposits is a long and costly business and can be done only by organisations with substantial capital resources or by the Government, employing modern methods of prospecting and drilling, and that by these means important discoveries of coal, potash and iron ore have recently been made.

W. E. Wrather similarly considered the outlook for future discovery in North and South America; he suggested an appraisal of the prospects of future discovery by assuming that known mineral-producing areas are a general measure of the possibilities of unexplored but geologically favourable regions, and that, if this principle be applied to the porphyry copper areas of the western United States, to the Canadian shield, and to Latin America, there is good prospect of the discovery of important new deposits.

H. G. Raggatt described the outlook for future discovery in Australia. He concluded that, apart from gold deposits and in the vicinity of working mines, most, if not nearly all, of the metalliferous vein deposits that could be discovered by ordinary prospecting methods have already been found, and that further discovery will depend not only on the application of detailed geological techniques and of geophysics, but also upon favourable economic incentives to promote the development of new deposits.

Much new and interesting information was brought together under the general heading of inorganic fertilizers in conservation. J. le Cornec and K. D. Jacob gave estimates of world supplies of the principal plant nutrients, and Sven Nordengren discussed those of Sweden. It appears that while the reserves of medium-grade phosphate and of potash are adequate for several thousands of years, the reserves of high-grade phosphate are relatively very small and will have to be husbanded. Papers on the economics

of world availability and use of fertilizer materials were given by H. A. Curtis, who drew on the valuable experience of the Tennessee Valley Authority on the production and use of phosphatic and other fertilizers, and by R. E. R. Grimmett (New Zealand) and J. N. Ray (India).

Conservation in mining and milling was considered under several sub-heads. R. B. Beilby (Great Britain), Sven Dalhammar (Sweden), Paul Audibert (France) and R. Arce (Bolivia) submitted papers on metallic mine mechanization to increase recovery; L. Blum-Picard and J. A. Barr, and others, on the mechanization of non-metallic mines; and papers from Canada, Great Britain, the United States and Austria were read on new processes for the utilization of low-grade ores.

Conservation in manufacture was a topic which covered such subjects as conservation of iron and steel in production, treatment of waste gas, conservation of non-ferrous metals, and design as a factor in conservation. Conservation by corrosion control was discussed in a wide range of papers.

Under conservation by substitution, papers on the future of light metals were presented by H. Sutton, O. C. Ralston and Jean Matter, in which much interesting new information was given on the properties, uses, manufacture and possible commercial production of titanium. This metal, in the mineral ilmenite, occurs in very large quantities, and it would find extensive application if its price could be reduced to within the range of those of commercial metals. Great interest has recently been aroused in this metal because it is now obtainable in a ductile state, and because iron can now be produced from titano-magnetite (ilmenite), leaving slag very high in recoverable titanium. Ralston suggested that if low-cost electric power for production of magnesium is restricted in supply, it would be better to use the magnesium to produce a like weight of titanium which would be twice as useful for structural purposes and would, if substituted for light alloys, conserve the use of copper and zinc.

P. L. Teed described the production of magnesia and magnesium from sea water. In Great Britain, magnesia, for the manufacture of high-grade refractories, has been obtained from sea water, on a commercial scale, since 1937. During the War, such magnesia was used as a source of magnesium in place of imported calcined magnesite. R. Bloch described the use of solar energy in evaporation from the Dead Sea water in the production of potash.

The recovery of metals from scrap was discussed by H. J. Miller and C. W. Merrill. The latter gave estimates of the quantities of minerals-in-use, and showed that the quantity of metal-in-use is a rough measure of a community's potential capacity for industrialization and its standard of living.

In the course of the afternoon plenary meetings, D. N. Wadia and D. H. McLaughlin read papers on metals in relation to living standards. The latter considered that the correlation between metallic production and living standards is low, and that between consumption and living standards only moderately higher; these standards depend upon productivity, a function of integrated regional economics. Wadia considered that in under-developed countries mineral resources affect standards of living in that they can be exchanged for fabricated metals and other needed products from industrially developed countries. F. Blondel presented a paper on mineral research, in which he made a strong plea for a more intensive prospecting of the under-developed countries by modern methods, and the provision of adequate funds for this where necessary.

Part of the work of the Fuels and Energy Section was closely related to that of the Minerals Section. For example, it included consideration of new techniques for increasing coal production, with particular reference to mechanization and strip mining. One session was devoted to the underground gasification of coal, on which large-scale experiments, with continuous operation for many months, are now in progress in the United States, Belgium and Morocco. Another session considered techniques of oil and gas discovery and production; one paper, for example, by M. H. Parks, dealt with petroleum production from continental shelves (to depths of 60 ft.). The techniques and results of aeromagnetic surveying were described by J. R. Balsley, who considered that the airborne magnetometer provides a low-cost and reasonably accurate magnetic map which can be used to delineate localities for more expensive and detailed ground work, both geological and geophysical, but it does not eliminate the need for ground surveys. Other papers described the production of oil from shale in the United States, in Sweden, and in Brazil, while the papers presented at the plenary meetings included a review of critical shortages in world resources of fuel and energy, by J. C. Parker; and one on estimates of undiscovered oil and gas reserves, by A. I. Levorsen.

The work of the Minerals Section was reviewed by G. C. Monture, Department of Mines and Resources, Ottawa, Canada, at the final session of the Conference. He said that the consumption of minerals is increasing and will continue to increase with improving standards of living, but that, given the essential basis of peace, no immediate shortage of minerals is apparent. There are as yet, however, no reliable estimates of the mineral resources of the world, because any such estimates must vary with changes in costs, with technical advances in mining and metallurgy, and with national policies on taxation. Political and economic stability and national policies are the determining factors in the exploitation and development of mineral deposits. It is none the less important that the appraisal of mineral resources of each country should be seriously attempted, and the basis for this is a well-organised and well-staffed geological survey. We will not begin to know the mineral resources of the world until national barriers are broken down; but if problems are approached in a spirit of international co-operation, the results achieved to date in the mineral field can be increased many times.

F. Dixey

RADIO ASTRONOMY

During recent years important advances in astronomical knowledge have accrued from the application of radio methods of observation. The striking progress in this field has followed largely from the improvements in radio and radar techniques developed during the War. At the British Association meeting at Newcastle upon Tyne, three British research organisations which have played a major part in radio-astronomical research were represented in the contribution of papers before Section A outlining some aspects of recent progress.

In the first paper, J. S. Hey described investigations at the Army Operational Research Group on radio emissions from sunspots and solar flares. Intense radio noise emanating directly from the sun was first identified in 1942, when it caused severe interference with Army radar equipments operating at wave-lengths of a few metres. Since the War, more detailed observations of the phenomenon have been made. The radio noise from a sunspot is mostly radiated in a directional beam with its axis approximately normal to the spot. This is indicated by the marked peak of the mean daily intensity which occurs during a few days roughly centred about the passage of the spot across the central meridian of the visible hemisphere of the sun. The intensity often fluctuates rapidly, but in some cases appears fairly steady. Only a proportion of sunspots produce appreciable emissions, the larger spots being the more likely to produce high intensities.

The radio noise associated with solar flares consists of sudden bursts of emission occurring almost simultaneously with the flares, which are normally observed visually as sudden increases of intensity of the $H\alpha$-line from regions in the vicinity of sunspots. Only a proportion of the flares have associated radio bursts, the bigger flares being the more likely to produce strong radio emissions. The radio bursts do not appear to be sharply beamed like the radiation from sunspots, for the chances of a radio burst when there is a flare are fairly evenly distributed with respect to the flare location on the disk of the sun. However, the recordings at a wave-length of 4 m. so far obtained suggest a greater chance of a burst when there is a flare on the eastern, or approaching half of the visible hemisphere of the sun, as compared with the western, or receding half.

Although visual flares grow rapidly, they do not compare in abruptness with radio bursts, which often rise in intensity by more than a hundred times in less than a minute. Time differences of some minutes often occur between the phenomena. Detailed study of the relationships between visual flares and radio bursts is hampered by the incompleteness of visual data, partly owing to the restriction on visibility due to cloud and fog, and partly to insufficient continuity and detail of most visual observations. Valuable secondary data of solar flares are provided, however, by certain geophysical effects, namely, those arising from enhancements of ionospheric D-layer ionization due to ultra-violet radiation from solar flares. These increases of ionization may be observed by their influence on the absorption or reflexion of radio waves at appropriate wave-lengths. Absorption causes weakening or fade-outs of long-distance radio-communication on wave-lengths around 20 m. and of radio noise from the Milky Way on wave-lengths around 10 m. (which are just short enough to penetrate the ionosphere). Reflexion effects which may be observed at very long wave-lengths of the order of 10 km. are the enhancements of received atmospherics or phase shifts in continuous-wave reflexions. When a solar flare is of very high intensity, the elements of the terrestrial magnetic field may undergo a characteristic deviation known as a magnetic crochet. A statistical study is being made of the relationships between radio bursts and the various indications of solar flare activity.

Measurements are also being made of the spectrum of the radio emission. The radio spectrometer consists of a panoramic receiver tuning rapidly over a range of wave-lengths. This necessitates simple tuning while maintaining high sensitivity. A suitable receiver, with the tuning sweeping from 3 to 6 m. wave-length in $\frac{1}{4}$ sec., has recently been constructed and put into operation at the Army Operational Research Group. A conical dipole aerial is used to obtain sufficiently uniform response over the range of wave-lengths.

The second paper was given by F. G. Smith, who described recent investigations at the Cavendish Laboratory, Cambridge, on radio noise from the galaxy. He began by comparing characteristics of visual and radio astronomy. These two branches of astronomy utilize respectively two wave-length bands of electromagnetic radiation which can penetrate the earth's atmosphere, namely, the visual and near-visual range covering about four octaves, and the radio range from about 1 cm. to 20 m. covering ten octaves. But whereas visually opaque gaseous regions may allow radio waves to pass through them, a visually transparent ionized gas may be opaque to radio waves. The sun's corona consists of highly ionized gas at a temperature of about a million degrees, and this is the region which a 'radio telescope' would observe.

A fundamental problem concerning galactic radiation is to determine whether it originates from stars or from diffuse ionized gas in interstellar space. To locate sources of the size of stars requires high resolving power. A resolving power of 1 minute of arc at a wave-length of 4 m. would need an aerial system with an effective aperture of about two miles square. This practical difficulty has been overcome by means of an interference technique. Two aerial systems, each having a broad sensitivity pattern in a north-south plane and a narrow beam (about $\pm 3°$) in the east–west plane, are spaced 120 wave-lengths apart in the east–west direction. The two aerials are connected together, thus dividing the beam in the east–west plane into a series of narrow interference lobes. As the earth rotates, a point source in passing alternately through the maxima and minima of the lobe system would produce a periodic signal at the receiver. The time of passing the central maximum gives the Right Ascension (α) of the source, and the Declination (δ) is found from the periodicity, which is proportional to sec δ. By this method two major sources, of angular diameter less than 5′, have been distinguished in Cygnus and Cassiopeia, and their positions have been determined to an accuracy of about 5′. In addition, twenty-three minor sources have been detected.

None of the sources can be identified with bright visual stars. It is suggested, however, that a star with a dim visual surface may have an atmosphere containing very high-energy electrons possibly accelerated by some electromagnetic process. To deduce the particle energy which could produce the radiation, it is necessary to know the distance and diameter of the sources. The parallax has been shown experimentally to be less than 1′, thus indicating that the distance is greater than one-fiftieth that of the nearest known star. As the general distribution of galactic radiation is roughly the same as that of visual stars, the distance may be taken as of the same order as that of the nearest visual stars. The fluctuations which occur in the Cygnus source can be as short as ten seconds, and, if due to variations of emission over the sources, this indicates a diameter less than ten light-seconds, which is the order of size of an average visual star. With these assumptions,

the effective temperature to produce the observed radio emission is about 10^{14} degrees. Unless some special mechanism is responsible for maintaining coherent oscillations in stellar atmospheres, the radiation must be due to electrons in random motion with energy at least 10^{10} electron-volts. In this case, the energies are sufficiently great to suggest that the origin of cosmic rays may be the same as that of the radio waves.

In the third paper of the series, A. C. B. Lovell described recent research in meteor astronomy at the University of Manchester by means of radio reflexion or radar methods. Meteors consist mostly of minute pieces of debris, far too small to be observable by direct radio reflexions. The speed of the meteors is so great that as they rush into the atmosphere of the earth they burn away at heights of about sixty miles. Until recently, the streaks of light produced by the burning meteors provided the only method by which astronomers could study this phenomenon. Such observations are hindered or prevented by cloud and moonlight, and are impossible in daylight. On the other hand, the burning meteor leaves behind it a dense trail of electrons which can reflect radio waves. The development of radio techniques has removed the major visual limitations and now enables meteoric activity to be surveyed by day and night in any weather conditions.

An important consequence of the radio observations has been the discovery of great meteoric activity in summer day-time. The well-known visual meteor showers which occur on about a dozen occasions a year usually last for a few nights. The summer day-time showers detected by the radio method are far more extensive and attain higher rates. The daylight activity, which in May comes from the direction of Pisces, develops rapidly, extending over a wide belt stretching towards the sun, and continues as a great succession of meteor showers until late August.

The origin of the streams of meteoric debris is a most important problem of meteor astronomy. It is almost certain that most of them move in orbits around the sun. A few are associated with comets; but it is unlikely that this is the case with all of them. There is difference of opinion as to whether the meteoric debris is all localized in the solar system or whether some comes from interstellar space. The radio observations now being made will help to answer these questions. The accurate determination of speeds will resolve the problem as to whether any meteors originate from outside the solar system. The high speeds involved—around 100,000 miles per hour—make measurement difficult. The method being used at the University of Manchester is to derive the speed from the fluctuations of amplitude of the radio echo as the meteor trail passes through the region where the perpendicular from the observing equipment meets the trail. A consideration of the Fresnel zones contributing to the reflexion shows that rapid fluctuations occur in this region and the periodicity depends on the speed.

The radio echoes from meteor trails after their formation show many complicated variations. A detailed study is being made of the complex behaviour of the trails, which depends on the atmospheric conditions in the region of formation. Thus, apart from the astronomical value of the radio methods of meteor observation, information of importance in the study of the physics of the upper atmosphere is being obtained.

J. S. Hey

OBITUARIES

Sir Edwin Pascoe

With the recent death of Sir Edwin Hall Pascoe, Indian geology has suffered another severe loss, a loss that, as will be seen later, is particularly untimely. Pascoe, who died in London on July 7, was the son of Edwin Pascoe and Mary A. Hall, and was born on February 17, 1878. He was educated at St. John's College, Cambridge, of which he was a Foundation scholar.

After a short period of scholastic work in England, Pascoe joined the Geological Survey of India in 1905, becoming director in 1921. He retired from the service in 1932.

Soon after arriving in India, Pascoe was detailed as one of the party to assist the late Mr. C. S. Middlemiss in the investigation of the Great Kangra earthquake of April 4, 1905, thus receiving a quick introduction to a form of geological investigation that falls too often to the lot of the officers of the Geological Survey of India. In the autumn of the same year, Pascoe was sent to Burma to commence a systematic study of the areas in which European companies were developing oil concessions, and to assist the Government of Burma in problems arising from this development, especially in its effects upon the economic conditions of the hereditary oil-diggers or *twinzas*. This first season's field-work really determined Pascoe's life interest and his career, as so often happens, showing how important it is for the director of a geological survey department to allot the right work to a man as early as possible in his career.

As a result of his first season's work on oil, Pascoe was entrusted with a survey of the oil resources of the whole Indian Empire, and after three field seasons in Burma (1905–9) he surveyed in turn the oil resources of Assam (1910–12), and of the Punjab and the North-West Frontier Province (1912 and 1914–15). In 1913 he was sent to the Persian Gulf, the Arabian Coast and West Persia. With this widespread experience, Pascoe became a recognized authority on the geology of petroleum, and this led to his being appointed to accompany the Slade Oilfields Commission in the Persian Gulf in 1913–14.

Immediately before Pascoe was appointed director of the Geological Survey of India, the sanctioned gazetted strength of the department had been raised from twenty to thirty as a result of the efforts of Sir Henry Hayden. Pascoe, in fact, took over a department with twelve vacancies; these were filled gradually, and the department did not reach its full strength until 1928. This increased strength enabled Pascoe to increase the number of field circles from three to six, and to allot a much increased number of men to Burma. The survey of the coalfields of India had been one of the primary tasks of the Geological Survey of India in its early days, when the topographical maps were very inferior as compared with the results of modern surveys in India. The commercial development of many of these fields had rendered urgent their re-survey geologically on modern maps, where these existed, both in order to help the mining industry, and also because it had become necessary to estimate what proportion of India's coal reserves could be regarded as of superior quality, since Government policy with reference to the mining industry depended fundamentally upon

such knowledge. In consequence, Pascoe formed for this purpose a Coalfields Party, and the results of the work of this party are represented by a series of *Memoirs* mainly by Dr. C. S. Fox (now Sir Cyril Fox), with one by E. R. Gee.

While he was director, Pascoe was a trustee of the Indian Museum and president of the governing body of the Indian School of Mines, his period coinciding with the planning and founding of the School, in which Pascoe took a leading part.

After his retirement from Government service in 1932, Sir Edwin Pascoe was appointed (in 1934) to the Geological Survey Board in London, and in 1935 he joined the Geological Advisory Panel of the Anglo-Iranian Oil Company, upon which he remained until his death.

Sir Edwin held the degrees of Sc.D. (Cantab.) and D.Sc. (London). He was president of the Mining and Geological Institute of India in 1924, and in 1930 was elected an honorary member of the Institute.

We must now notice Sir Edwin Pascoe's scientific work. In summary, he was the author of four *Memoirs*, and of thirty-four papers in the *Records*, of the Geological Survey of India, plus two papers with joint authorship, as well as being the principal contributor to two "Quinquennial Reviews of the Mineral Production of India". Of his papers in the *Records of the Geological Survey of India*, it is only the first twelve and one later paper that describe his own original work. Those before 1920 all arose from his surveys of the oil-bearing formations of India and Burma and were, therefore, papers leading up to his *Memoirs* on this subject. But to one of these *Records* papers special attention must be directed, namely, a very early paper on "The Asymmetry of the Yenangyat–Singu Anticline, Upper Burma" (*Rec. Geol. Surv. Ind.*, **34**, 253; 1906). This paper is of much economic importance and directs attention to a structural feature of fundamental importance to the study of any oil-field in which the folding is asymmetrical. Pascoe points out the important effect of the "hading of the crest-locus" not only in locating well-sites, but also in the estimation of the value and prospects of an oil field. Pascoe's four *Memoirs* (*Mem. Geol. Surv. Ind.*, **40**, Pts. 1, 2, 3; 1912–20; and **48**, 1922), however, constitute his principal original contribution to the geology of India and Burma.

As a result of his studies of the oil-fields of India and Burma and elsewhere, Pascoe became an authority on the younger, Tertiary, formations of this part of the world. His work led to two interesting speculations. The first of these is presented in his paper "The Early History of the Indus, Brahmaputra, and Ganges" (*Quart. J. Geol. Soc.*, **75**, 138; 1919), in which he proposes the hypothesis that the three main rivers of Northern India were once part of a single river rising in Assam, flowing north-west along the foot of the rising Himalaya, and then turning south-west towards the Arabian Sea. This hypothesis was also advanced quite independently by the late Dr. G. E. Pilgrim in a paper published in India (*J. Proc. Asiatic Soc. Bengal*, n.s., **15**; 1919). Pascoe called this river the "Indobrahm" and Pilgrim the "Siwalik River".

The second speculation relates to the age of the Saline Series that underlies the Cambrian rocks of the Salt Range in the Punjab. Wynne, who originally mapped the Salt Range (*Mem. Geol. Surv. Ind.*, **14**; 1878), concluded that this series was in its normal position and therefore was of early Cambrian age or older. Middlemiss (*Rec. Geol. Surv. Ind.*, **24**, 28; 1891) proposed the hypothesis that the salt might be of intrusive origin. Pascoe, as a result of his studies in the Punjab, came, however, to the conclusion that the salt and salt-marl are of Tertiary age and owe their formation to the desiccation of the Punjab Nummulitic gulf; and that the position of the Saline Series, including the overlying Purple Sandstone, below the Cambrian and other Palæozoic rocks of the Salt Range, is due to an extensive overthrust from the north (*Mem. Geol. Surv. Ind.*, **40**, 358; 1920). This hypothesis had already been advocated by Noetling and Koken and accepted as a possibility by Holland and Hayden (Pascoe, *loc. cit.*, 383). However, as this was a hypothesis the truth of which could only be established by detailed mapping, Pascoe determined when he became director to have such a survey made, especially as more detailed topographical maps were available than in the time of Wynne; he allotted this task to E. R. Gee. As Dr. Gee related in his recent lecture to the Geological Society of London, he thought at first that the Tertiary hypothesis was the correct one, but eventually the detailed results of his mapping have convinced him that Wynne's original view must be upheld, and in this Gee has convinced a number of experienced geologists who have visited him in the field and seen his evidence.

After Sir Edwin Pascoe had retired from India, I was able to arrange with the Government of India that Sir Edwin should be entrusted with the preparation of a new, third edition of the "Manual of the Geology of India". The first edition was that by H. B. Medlicott and W. T. Blanford, published in two volumes in 1879. A second edition of this Manual, that is, of Parts I and II, revised by R. D. Oldham, was published in one volume in 1893. Once Sir Edwin had been entrusted with the responsible and difficult task of producing a third edition of this "Manual", he devoted almost the whole of his time to its completion. He soon found that he could not do justice to the mass of new material in less than three volumes, with a fourth volume for maps and index, and this is the size finally agreed upon. The work was practically finished and in the press when the Second World War intervened. Shortage of paper prevented the printing-off and eventually the type was melted down for war purposes. Consequently the whole work has had to be reset. This delay made it necessary for Sir Edwin to revise much of the text to bring it up to date. The present position of this work is that volume I is expected to be issued in the spring of 1950. The whole work when finished will be a grand monument to Sir Edwin Pascoe, a monument also of enduring value to all students of Indian geology.

The above is an account of some of Sir Edwin Pascoe's administrative and scientific achievements. Writing of his personality, one must record that he was a man of eminently sound and well-balanced views who judged fairly and without bias every problem that came before him, whether scientific, administrative or personal; and this soundness caused many to seek his advice on matters quite outside the professional sphere. In his leisure time he found solace in tennis and golf, in music (being no mean exponent on the piano) and in chess, of which in his early days he played games by post while in camp, specially with Cotter. He had also a reverence for antiquity and antiques, and, as a hobby, indulged in research in old church registers. He married Mis

Maclean of Beauly, Inverness, and on retirement from India lived first at Royston, and later at Harpenden. L. L. FERMOR

WE regret to announce the following deaths:

Dr. Arthur M. Cloudman, senior biologist at the Argonne National Laboratory in the United States, formerly research pathologist at the Roscoe B. Jackson Memorial Laboratory, on August 8, aged forty-eight.

Prof. Alexander Meek, emeritus professor of zoology in the University of Durham (King's College, Newcastle upon Tyne), aged eighty-four.

Sir Richard Needham, C.I.E., known for his work in connexion with medical studies in India and other parts of Asia and in Africa, on October 24, aged seventy-two.

NEWS and VIEWS

Royal Society: Medal Awards for 1949

HIS MAJESTY THE KING has been graciously pleased to approve the following recommendations made by the Council of the Royal Society for the award of the two Royal Medals for 1949: Sir George Thomson, for his distinguished contributions to many branches of atomic physics, and especially for his work in establishing the wave properties of the electron; Prof. R. A. Peters, for his distinguished biochemical researches, in particular his investigations of (i) the biochemical role of vitamin B_1 in tissue metabolism; and (ii) the mechanism of the toxic action of lewisite and other arsenical compounds.

The following awards of medals have been made by the President and Council of the Royal Society:

Copley Medal to Prof. G. C. de Hevesy, for his distinguished work on the chemistry of radioactive elements and especially for his development of the radioactive tracer technique in the investigation of biological processes.

Davy Medal to Prof. A. R. Todd, for his structural and synthetic studies and achievements in organic and biochemistry, with special reference to vitamins B_1 and E and the naturally occurring nucleosides.

Sylvester Medal to Prof. L. J. Mordell, for his distinguished researches in pure mathematics, especially for discoveries in the theory of numbers.

Hughes Medal to Prof. C. F. Powell, for his distinguished work on the photography of particle tracks and in connexion with the discovery of mesons and their transformation.

Nobel Prize for Chemistry for 1949: Prof. W. F. Giauque

THE Nobel Prize for Chemistry this year has gone to Prof. W. F. Giauque, professor of chemistry in the University of California. Of French-Canadian extraction, he first trained as an engineer, but soon became interested in physical chemistry and joined the famous Berkeley School, founded by G. N. Lewis and presided over by him until his death a few years ago. Giauque's name first became familiar to a wider circle by his discovery in 1929 (with Johnston) of the rare oxygen isotope 18 (and soon afterwards of the still rarer one 17), the existence of which he deduced from the interpretation of absorption spectra. He is best known, however, for his suggestion—independent of that of Debye—of the so-called magnetic method of cooling which, partly in his own hands, has in the last fifteen years extended the temperature region attainable in the laboratory to about a hundredth of a degree off the absolute zero. The great bulk of his work and that of his collaborators is composed of a systematic, patient and very accurate investigation of specific heats at low temperatures, guided by a thorough understanding of the theoretical problems involved. It was largely his work which has created for the chemist the conditions necessary for applying the Third Law of Thermodynamics, and has provided him in this way with a wealth of material for the calculation of equilibrium data. Giauque's low-temperature laboratory, founded on sound engineering practice, was the nucleus and is now the centre of America's fast-growing school of low-temperature research.

St. Bartholomew's Hospital: Prof. F. L. Hopwood

PROF. F. L. HOPWOOD has retired from St. Bartholomew's Hospital, where he has been physicist since 1919, and professor of physics in the Medical College since 1924. The years have been active in teaching, research and committee work; in the last respect he has been an active member of the British Empire Cancer Campaign since its formation in 1924 and of the British Committee for Radiological Units over the same period. It is particularly to radiology and ultrasonics that his research work has been directed, though not exclusively, for his work in submarine acoustics in the First World War led to Admiralty recognition and an award. When the Strangeways Laboratory at Cambridge took up the study of biological effects induced by X-rays and radium, Hopwood's services as a physicist were timely and ensured a quantitative basis for this research work, which has had such an important bearing on the treatment of malignant disease. A wide range of interests is a fortunate equipment for a hospital physicist, for at some time or other a large proportion of those engaged in treatment meet difficulties in which he can help, and Hopwood has served well here. His knowledge of X-ray technique and method was put to the test when 'Bart's' decided to install a million-volt X-ray installation for treatment. This development was for some reason not followed in other hospitals of the country, though there are now many signs going to show that high-voltage (X-ray or electronic) devices will come into much more general use in the treatment of cancer in the next few years. Hopwood was a Sylvanus Thompson medallist and an honorary member of the Faculty of Radiologists, an honorary fellow of Queens' College, Cambridge, was given the degree of M.A. (Cantab.) *honoris causa* in 1940 and retires with the well-deserved title of professor emeritus in physics in the University of London.

Metallurgy at Birmingham

THE professorial staff of the Department of Metallurgy of the University of Birmingham has now been further enlarged by the appointment of two new professors: Dr. G. V. Raynor as professor of metal physics, and Dr. A. H. Cottrell as professor of physical metallurgy. Dr. Raynor was educated at Nottingham High School and Keble College, Oxford. At Oxford he worked under Dr. W. Hume-Rothery as research

assistant and demonstrator; in 1945 he went to Birmingham as Imperial Chemical Industries research fellow and in 1947 became a reader in theoretical metallurgy. His research work has been mainly on the structure of metals and alloys, on which he is an acknowledged authority. During the War he worked, on behalf of the Ministry of Aircraft Production, on the structure of complex aluminium alloys. Dr. Cottrell is a graduate of the University of Birmingham, and his research work has been conducted in the Department of Metallurgy. During the War he was engaged on research in connexion with the welding of armour plates. He was appointed lecturer in 1943. The Department of Metallurgy thus has, in addition to the director (Prof. D. Hanson), three others professors, namely, Prof. A. J. Murphy (who recently succeeded Prof. L. Aitchison) and the two referred to above.

George Eastman House, Rochester, N.Y.

THE George Eastman House in Rochester, New York, was opened to the public on November 9. The house has been given by the University of Rochester to George Eastman House, Inc., a corporate body of eleven directors, and is a memorial to George Eastman, who was a great pioneer in photography, particularly with regard to the development of the roll film. This public educational institute has been designed for placing on exhibition the technological developments and applications of photography, both past and present, and for aiding and encouraging research. Facilities are available for exhibitions, demonstrations, conferences, research, etc. Of particular interest are three collections furnished by the Eastman Kodak Co.; they are the collections of George Eastman himself, acquired originally from J. M. Eder of Vienna, and those of Gabriel Cromer of Paris and François Doublier. Some of the more outstanding items are cameras bearing Daguerre's signature, original prints taken by Fox Talbot in the 1840's, albums from the libraries of Victor Hugo, Napoleon III and Queen Victoria, and two original Lumière cinematographs.

Besides the display of popular material with many working models, moving displays, etc., there is at the rear of the building a hall of contemporary photography which contains many static and dynamic exhibits of interest to the more scientifically minded. Examples are shown of the photographic techniques used by men of science in investigations in the realms of nuclear physics, astronomy, X-ray and electron diffraction, and spectrography. The section on nuclear physics contains on a wall panel a big enlargement of a nuclear 'star' explosion, and to the right a three-dimensional model explaining how the explosion took place. A group of nuclear track photorecords of electrons, mesons, protons, etc., is displayed on an inclined counter under the wall panel. The role of photography in industry is also depicted with exhibits on such subjects as photo-recording, high-speed analysis, photomicrography, photogrammetry, electron microscopy, industrial radiography, graphic arts, television, microfilming, medical photography and photofluorography. Demonstrations are also given of stereo-projection and aerial photography, and map-making.

Dimensions of Animals and their Muscular Dynamics

ON November 4 Prof. A. V. Hill gave a Friday Evening Discourse at the Royal Institution, his subject being "The Dimensions of Animals and their Muscular Dynamics". He pointed out that mammals vary in size in the ratio of 40,000,000 : 1, from 4–5 grams to 150 tons. In general, a small animal carries out each movement more quickly than a large animal, its muscles having a higher 'intrinsic speed' and being able, in proportion to their size, to develop more power. In a group of 'similar' animals there is an evident tendency for the maximum speed, and the height and length of jump, to be independent of size. This depends upon a variety of limiting factors, particularly the mechanical strength of the structure of the animals, and the oxygen supply to their muscles. In the cetaceans, from porpoises to whales, the maximum speed that can be maintained (about 15 knots) is much the same in spite of a 5,000-fold variation of weight. A calculation of the drag due to skin friction shows that the power required to overcome it would be impossibly high if turbulence occurred over more than a small fraction of the surface.

With regard to the performance of a variety of land animals in jumping and running, high speed, together with endurance, may be obtained by economy of design, as in the gazelle; high speed, together with rapid acceleration, by a greater output of power, as in the cheetah. The maximum speeds of race-horse, greyhound and whippet are in the ratio 124 : 110 : 110, although their weights are about as 6,000 : 300 : 100. The larger animal, however, can keep up its maximum effort longer before exhaustion sets in. During maximum effort the frequency of the heart-beat of the smallest animals must be thousands per minute, of the largest animals it must lie in the twenties or thirties. Since the heart is nearly a constant fraction of the body-weight, this means that the maximum oxygen supply to a unit weight of muscle must be about in these proportions—which is why the smaller animals can exert relatively more power than the larger ones. Various points of general interest discussed by Prof. Hill were as follows: (1) he predicted that up a steep hill the speed of race-horse, greyhound and whippet would be in the reverse order to that on the flat; (2) he proposed an explanation of the fact that whales can remain for long periods under water without breathing; and (3) he showed that the characteristic relation in muscle between speed of shortening and load determines the gear ratio of bicycles for power or efficiency.

Crosby Hall: International Residence for University Women

CROSBY HALL, the international hall of residence in London for university women from all over the world, was opened in 1927 by the British Federation of University Women, which had raised more than £50,000 for the purpose of acquiring the Hall and building a residential wing. The Hall quickly became a centre for international culture and friendship where university women from every country were able to live and study, meet and exchange views, come for short visits or use the club facilities provided. Crosby Hall was requisitioned during the War but re-opened in 1946; and since this date approximately three thousand university women from forty-five different countries have resided there. The Great Hall, which dates from 1466, is the main building of the residence, and, curiously enough, it was erected originally in the City and was moved in 1909 stone by stone and beam by beam to the present site on the Chelsea Embankment. The only qualifi-

cation necessary for using Crosby Hall is membership of a national federation of university women, but residence is in general limited to one year, preference being given to research and postgraduate students. Members are welcomed for short visits and, accommodation permitting, university women working in London can also live at Crosby Hall. The range of nationalities, professions and interests represented at the Hall is exceedingly varied, and all who have stopped there praise the spirit of international co-operation and tolerance that prevails. The demand for accommodation is very great, and an endowment fund has been launched to build a second residential wing, a library and additional common rooms, and also to endow fellowships. The first Crosby Hall scholarship from the new fund was awarded this year to Dr. Leonor Fiorini of Buenos Aires, Argentine, who specializes in hydro-geology, and two further scholarships have been endowed—a City of London scholarship and a New Zealand one. New Zealand and Canada have each contributed £1,000 to the fund. An international sale to raise a further £4,000 will be held at Caxton Hall, London, S.W.1, on November 15, from noon to 7 p.m. (admission 1*s*.).

Petroleum Plant at Stanlow

A SMALL booklet, some eighty pages in length, and entitled "Britain's New Industry: Stanlow 1949", has been published by the Shell Chemical Manufacturing Co., Ltd., and describes the oil installation and refining plant at Stanlow, which was established on the south bank of the Manchester Ship Canal in 1922. The booklet deals with the production of various kinds of oils, wax cracking, ester salts ('Teepol'), and similar products and chemicals obtained from petroleum. It gives a popular account of the plant and processes, and is profusely illustrated. The cracking processes are described in outline, for example, that for the production of *iso*-propyl and secondary butyl alcohols. The uses of the products are described. The processes used in America are also outlined, such as the production from propylene of allyl chloride, which is a raw material for the manufacture of plastics and synthetic glycerol. Butylene gives butadiene, the main raw material for the manufacture of synthetic rubber. At the end of the book there is a simple scheme of the chemistry of the processes which may be of interest to elementary students of organic chemistry and to business men. The production is very lavish, many of the illustrations being in colour.

Predatory Birds of Great Britain

BELIEVING that there is a lack of knowledge throughout the country about the laws concerning the protection of wild birds, and especially the predatory birds, the British Field Sports Society has prepared a useful guide to show clearly the protection which the law affords them county by county. The book contains a clear description of each species, including measurements, range and habits, and in many cases drawings are included of the birds both settled and on the wing. It is also indicated which species, in the Society's opinion, are harmful and which are not. In the first category are those birds which, by reason of their numbers or habits, do very considerable damage not only to game birds, but also to song birds. Examples of these are the jay, magpie and sparrow-hawk. In the second category are those predatory birds such as harriers, kites and buzzards which, either because of their habits or their rarity, do little or no damage to the game preserver or the agriculturist. The booklet also includes tables showing the protection afforded county by county according to the Wild Birds Protection Acts. The handbook may be obtained from the British Field Sports Society, 51 Victoria Street, London, S.W.1, price 3*s*.

Announcements

THE second Progress Medal of the Photographic Society of America has been awarded to Mr. J. Dudley Johnston, for inspiring leadership and fostering photographic societies. The Medal, which is the highest award in the gift of the Society, was received, on Mr. Johnston's behalf, by Mr. Joseph Dombroff, at the annual convention in St. Louis, on October 21. Mr. Dombroff also read Mr. Johnston's Progress Medal Lecture entitled "Photography and Progress."

PROF. HERBERT DINGLE, professor of the history and philosophy of science, University College, London, will deliver a Norman Lockyer Lecture, arranged by the University of Birmingham and the British Association for the Advancement of Science, on November 22, in the Medical Theatre, University, Edmund Street, Birmingham. He will speak on "Modern Theories of the Origin of the Universe".

THE American Association for the Advancement of Science will hold its 116th meeting in New York City during December 26–31. Dr. Edmund W. Sinnott, of Yale, is retiring president of the Association, and Dr. Elvin C. Stakman, of the University of Minnesota, is president. Dr. Howard A. Meyerhoff is administrative secretary with headquarters at 1515 Massachusetts Avenue, N.W., Washington 5, D.C.

THE British Institute of Management, 17 Hill Street, London, W.1, has arranged a conference on current industrial problems such as incentives for management in the Welfare State, minimum wages, training for management, etc., to be held at Harrogate during November 17–20. Copies of papers are being circulated in advance to afford the maximum time for discussion.

THE Commissioners for the Exhibition of 1851 are compiling a centenary edition of their "Record of Science Research Scholars", which includes the names and careers of all who have held research awards given by them. Requests for particulars of their careers have been forwarded to all Scholars for whom the Commissioners have an address; but there remain some with whom it has not been possible to get into touch. Any past Scholar who has not received the printed request should communicate with the Secretary, Royal Commissioners for the Exhibition of 1851, 1 Lowther Gardens, Exhibition Road, London, S.W.7.

A WEEK-END conference on "Secrecy in Science" is being organised by the Cambridge Scientists' Anti-War Group and will be held during November 19–20 in Lecture Room 4, St. John's College, Cambridge. The meeting on November 19 opens at 2.30 p.m., and that on November 20 at 10 a.m. The conference will be open to all who are interested, and written contributions will be welcomed.

ERRATUM. In the communication by Dr. F. G. Mann in *Nature* of November 5, p. 785, the word '-quinolino-' was incorrectly printed throughout: thus the title should read "Structure and Colour in the 1 : 2-Dihydro-quinolino (3′ : 2′ : 3 : 4) quinolines".

CARBON DIOXIDE IN THE INTERCELLULAR SPACES OF LEAVES DURING PHOTOSYNTHESIS

By Dr. O. V. S. HEATH

Research Institute of Plant Physiology, Imperial College of Science and Technology, London

IT was recently found by Gabrielsen[1] that leaves of elder (*Sambucus nigra*), enclosed either in ordinary air of 0·03 per cent carbon dioxide content or air poor in carbon dioxide (0·0024 per cent) and illuminated with light of 1,100 foot-candles intensity, brought the carbon dioxide content to a constant value of about 0·009 per cent. He has suggested[1,2] that this 0·009 per cent represents a threshold value below which no photosynthesis can take place. Audus[3] found that even at high light intensities leafy shoots of cherry laurel gave out carbon dioxide into a slow stream of carbon dioxide-free air, although F. F. Blackman[4] and Maskell[5] had found no detectable quantity of carbon dioxide emitted by illuminated leaves under such conditions.

In 1938–39, as a part of an investigation of the relation between carbon dioxide assimilation and stomatal movement, I carried out experiments with *Pelargonium zonale* and *Begonia sanguineum* in which air of known carbon dioxide content was drawn through the intercellular spaces of the leaf at predetermined rates of flow by balanced push and pull; the leaf was illuminated with light at 2,450 foot-candles and the carbon dioxide content of the air emerging was estimated by a conductivity method. In this way, stomatal control of assimilation was entirely eliminated and the air of known carbon dioxide content was brought into direct contact with the walls of the assimilating cells. For this type of experiment, first suggested in principle by Prof. F. G. Gregory, somewhat complex apparatus was necessary and the technique has already been described in detail[6]. These experiments were terminated by the War, and it is only recently that an opportunity for detailed analysis of the results has occurred. The purpose of this preliminary communication is to record the approximate agreement, in the results so far calculated, of the carbon dioxide content of the air emerging from the leaf with the equilibrium value found by Gabrielsen for air surrounding a leaf in a closed system; also to indicate an interesting connexion between this value and stomatal response to carbon dioxide.

Air was passed into the leaf over an area of 9 sq. cm. and emerged from another 9 sq. cm.; the total area involved including the washer separating these two areas was some 23 sq. cm. Over a wide range of rates of flow (0·4–2·5 litres/hr.) and with either 0·03 per cent or 0·14–0·18 per cent carbon dioxide content in the air on entry, the air emerging from leaves of either species had a mean carbon dioxide content approximating to 0·01 per cent. Some representative results are presented in Table 1. The determinations were made over successive short periods, ranging from 1 m. 40 s. to 4 m. 40 s. for different experiments, so that considerable fluctuations in the individual values are to be expected, and these are indicated by the ranges in Table 1. During these 'through' experiments, stomatal apertures as indicated by the resistance porometer[7,8] varied over a wide range without apparently affecting the assimilation-rates. In one experiment (No. 19) with high carbon dioxide content (0·18 per cent) and high rates of flow (1·5 and 2·1 litres/hr.) the air emerging from a *Pelargonium* leaf showed a carbon dioxide content markedly in excess of 0·01 per cent (italics in Table 1), suggesting that the supply had been increased to a level at which carbon dioxide was no longer so severely 'limiting'. On the other hand, in one of the *Begonia* experiments (No. 13), similar high values were given at the lower but not at the higher rates of flow (italics in Table 1), and in general there is little correlation to be seen in the results between rate of carbon dioxide supply and carbon dioxide content of the air emerging. In any event, it clearly must be possible to increase the rate of carbon dioxide supply until the light intensity used or some other factor appreciably limits the increase in uptake; the most important result for the present purpose is the finding that even with a normal initial carbon dioxide content (0·03 per cent) and a low rate of flow through the leaf the mean carbon dioxide content of air emerging from the intercellular spaces is never reduced below 0·005 per cent.

It seems that the value of approximately 0·01 per cent represents the minimum carbon dioxide concentration at the surface of the assimilating mesophyll cell. There are, in effect, two sources of carbon dioxide supply: that in the external air, either outside the leaf or, in the present experiments, close to the cell

Table 1. 'Through' experiments

Expt. No.	Date	Rate of flow in litres (at N.T.P.) per hr.	Observations		% CO_2 content		
			Period (sec.)	No. (*N*)	Initial	Final	
						Mean (of *N*)	Range
(*a*) *Pelargonium zonale*:							
7*A*	27. 9.38	2·47	280	8	0·0298	0·0059	0·0048–0·0079
8*A*	5.10.38	2·08	,,	15	,,	0·0051	0·0034–0·0078
23	25. 8.39	1·01	100	11	,,	0·0075	0·0037–0·0122
,,	,,	1·87	,,	3	,,	0·0096	0·0075–0·0120
,,	,,	1·50	,,	7	,,	0·0083	0·0055–0·0117
9*A*	11.10.38	1·03	120	11	0·143	0·0091	0·0038–0·0155
,,	,,	0·69	,,	10	,,	0·0099	0·0077–0·0122
,,	,,	0·51	,,	9	,,	0·0082	0·0032–0·0150
19	24. 7.39	1·01	100	5	0·184	0·0115	0·0085–0·0151
,,	,,	*2·05*	,,	4	,,	*0·0165*	*0·0162–0·0169*
,,	,,	1·01	,,	8	,,	0·0083	0·0036–0·0131
,,	,,	*1·50*	,,	3	,,	*0·0197*	*0·0171–0·0225*
,,	,,	0·95	,,	3	,,	0·0119	0·0059–0·0153
,,	,,	0·69	,,	3	,,	0·0110	0·0081–0·0145
					Mean =	0·0102	
(*b*) *Begonia sanguineum*							
11	10.11.38	0·78	110	4	0·143	0·0073	0·0033–0·0126
,,	,,	0·59	,,	4	,,	0·0050	0·0020–0·0090
,,	,,	0·43	,,	6	,,	0·0057	0·0040–0·0083
13	17.11.38	1·04	,,	7	,,	0·0120	0·0084–0·0144
,,	,,	0·79	,,	3	,,	0·0105	0·0096–0·0111
,,	,,	*0·61*	,,	4	,,	*0·0160*	*0·0140–0·0176*
,,	,,	*0·43*	,,	6	,,	*0·0142*	*0·0098–0·0198*
					Mean =	0·0101	

Table 2. 'Over' experiments

Expt. No.	Date	Rate of flow in litres (at N.T.P.) per hr.	Observations		Log R	Initial	% CO_2 content Final	
			Period (sec.)	No. (N)			Mean (of N)	Range
(a) *Pelargonium zonale*								
23	25. 8.39	1·89	100	4	$\bar{1}$·297	0·0298	0·0174	0·0119–0·0238
,,	,,	,,	,,	4	$\bar{1}$·134	,,	0·0091	0·0076–0·0110
,,	,,	1·01	,,	4	$\bar{1}$·029	,,	0·0054	0·0016–0·0105
,,	,,	1·89	,,	4	$\bar{2}$·872	,,	0·0074	0·0068–0·0085
17	17. 7.39	1·00	,,	4	$\bar{1}$·671	0·184	0·0574	0·0431–0·0782
,,	,,	,,	,,	9	$\bar{1}$·398	,,	0·0229	0·0080–0·0319
20	26. 7.39	1·02	,,	4	$\bar{1}$·994	,,	0·1021	0·0861–0·1203
,,	,,	,,	,,	8	$\bar{2}$·950	,,	0·0223	0·0132–0·0282
,,	,,	,,	,,	4	$\bar{2}$·929	,,	0·0278	0·0266–0·0297
(b) *Begonia sanguinea*								
14	18.11.38	1·02	100	4	$\bar{1}$·989	0·0298	0·0169	0·0152–0·0199
,,	,,	,,	,,	8	$\bar{1}$·854	,,	0·0132	0·0109–0·0163
15	22.11.38	1·88	,,	4	0·121	,,	0·0173	0·0146–0·0215
,,	,,	,,	,,	9	0·033	,,	0·0163	0·0117–0·0233
11	10.11.38	1·02	120	10	0·074	0·143	0·0578	0·0409–0·0686
12	15.11.38	1·03	110	4	0·288	,,	0·0717	0·0591–0·0951
,,	,,	,,	100	6	0·122	,,	0·0422	0·0335–0·0493

surface, and the carbon dioxide of respiration produced in the cytoplasm. Owing to the latter, the carbon dioxide tension at the cell surface could never fall to zero even if carbon dioxide - free air were drawn through the leaf. (Unfortunately this experiment was not carried out owing to the outbreak of war.) That the carbon dioxide content of the air emerging should fluctuate so closely about 0·01 per cent over a wide range of rates of supply indicates that a similar value might be expected with a very slow stream of carbon dioxide - free air passed through the leaf, and this suggestion is supported by Gabrielsen's closed-system experiments. The results, in fact, appear consistent with his hypothesis of a threshold concentration for photosynthesis, though it appears improbable that a *true* threshold value should exist.

It is clear that in the present experiments, over the range of rates of carbon dioxide supply used, carbon dioxide was very severely 'limiting'. It appears that once inside the leaf all the carbon dioxide except the 0·01 per cent (approx.) is taken up with great efficiency. Some results from experiments in which air was passed *over* the leaf surface instead of *through* the intercellular spaces are presented in Table 2 for comparison with those in Table 1. Here the carbon dioxide had to diffuse into the leaf through the stomata. In the case of *Pelargonium*, when the stomata were relatively widely open (low 'log R') and the normal 0·03 per cent initial carbon dioxide concentration was used, the air leaving the leaf chambers showed the same low concentration as in the 'through' experiments, although the leaf area concerned was now only 9 sq. cm. This result was doubtless due to the design of the leaf chambers[6], which reduced the diffusion path to the leaf surface to at most 2 mm.; it is of importance as indicating that in similar 'over' assimilation experiments, carried out with non-turbulent flow of normal air but in the more usual and deeper types of leaf chamber, the carbon dioxide content near a part of the leaf surface *may*, in fact, be down to the 'threshold concentration', although the emerging air may show a much higher average value. This would render doubtful the effective area of leaf; it also stresses the need for caution in estimating the mean carbon dioxide content to which the leaf is exposed and using such an estimate to correct assimilation data to a constant carbon dioxide content. With relatively closed stomata (high log R) or with higher initial carbon dioxide contents, the *Pelargonium* leaves failed to reduce the concentration to the 'threshold value'; but even with 0·184 per cent carbon dioxide the depletion was severe and amounted to about 88 per cent of the total content in some cases.

The *Begonia* results are of some interest, for whereas in 'through' experiments (Table 1) the uptake of carbon dioxide was almost the same as for *Pelargonium*, in 'over' experiments (Table 2) the latter proved appreciably the more efficient. This might be expected from the small and localized areas of stomata and the long internal diffusion paths to the chlorenchyma in the *Begonia* leaf[8].

The value of approximately 0·01 per cent indicated for the carbon dioxide content of the air in the intercellular space system of a brightly illuminated leaf is of especial interest in view of a recent extension of the discovery of the sensitivity of the stomata to small changes of carbon dioxide tension[9]. In the further investigation of the response of wheat stomata to carbon dioxide, experiments carried out by Dr. F. L. Milthorpe in this Institute have shown that although there is very marked stomatal opening with reduction of carbon dioxide in the air supply from 0·03 per cent to 0·01 per cent, from 0·01 per cent to zero there is no evidence of any further opening. It appears likely, therefore, that the stomata respond only down to the minimum carbon dioxide content that normally occurs in the sub-stomatal cavities. Any response below this level would, of course, be of no biological advantage to the plant.

Detailed publication of the investigations mentioned will follow in due course, and further work along these lines is projected.

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[2] Gabrielsen, E. K., *Nature*, **163**, 359 (1949).
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[4] Blackman, F. F., *Phil. Trans. Roy. Soc.*, B, **188**, 503 (1895).
[5] Maskell, E. J., *Proc. Roy. Soc.*, B, **102**, 467 (1928).
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[7] Gregory, F. G., and Pearse, H. L., *Proc. Roy. Soc.*, B, **114**, 477 (1934).
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AMINO-ACIDS AND PROTEIN HYDROLYSATES

THERE was a large and attentive audience, including participants from the Continent of Europe, at each session of the recent symposium upon "Amino-Acids and Protein Hydrolysates" organised by the Food Group of the Society of Chemical Industry. The symposium consisted of six paper-reading sessions held in the William Beveridge Hall at the Senate House, University of London, and an exhibition of relevant equipment and techniques presented in the Physical Chemical Laboratory,

Imperial College of Science and Technology, South Kensington. The symposium opened on the evening of September 28 with an introductory address by Prof. E. C. Dodds. Prof. H. D. Kay was in the chair. Prof. Dodds had been asked to introduce the subject of the symposium by providing, within the space of a little more than one hour, a reasonably elementary review of the chemistry and biochemistry of the amino-acids, and he fulfilled this task admirably. He reviewed the history, discovery, chemistry and the properties of amino-acids, and followed on to a discussion on methods of synthesis. He rounded off this section of his address by discussing the modern thiazolone method of synthesis in which, starting with hydrocyanic acid, formaldehyde and ammonium chloride, a series of operations easily conducted at room temperature leads to high yields.

Prof. Dodds then turned to the metabolism of amino-acids and, after discussing the metabolic phenomena of deamination, transamination and specific dynamic action, reviewed modern work on this subject, such as the use of paper chromatography in the examination of venous blood following the ingestion of protein, the study of urinary patterns, and the use of 'tagged' atoms and 'double-tracers' to follow the metabolic paths of individual amino-acids. Then came a section on the clinical uses of protein hydrolysates for famine conditions and premature babies, and the therapeutic use of amino-acids, such as methionine and glutamic acid. Finally, Prof. Dodds considered the use of aromatic amino-acids to study the metabolism of bacteria with the view of discovering new chemotherapeutic agents, and the use of conjugated amino-acids in cancer therapy.

The morning session on September 29, under the chairmanship of Dr. Norman C. Wright (chief scientific adviser to the Ministry of Food), was opened by Dr. K. Bailey, who discussed the value of histograms in the interpretation of the analytical data of proteins. Dr. Bailey pointed out that hitherto such analytical data have been capable of only limited interpretation and that there is now a definite need for the situation to be remedied, since the development of new methods of analysis has made it possible for almost all the nitrogen of many proteins to be accounted for in terms of individual amino-acids. He then exhibited histograms relating to the frequency of occurrence of individual amino-acids in a number of different proteins over fairly small units of grouping, for example, 5–10 amino-acid residues/10^5 gm. of protein, and also histograms illustrating the frequency of occurrence of groups of amino-acids such as those with polar side-chains. Dr. Bailey discussed the conclusions to be drawn from the narrowness of the frequency-range within which various amino-acids fall, from a consideration of groups of amino-acids and also from the histograms of different groups of proteins. Finally, he emphasized the limitations imposed upon this method of approach by the small number of proteins which have been completely analysed, and the difficulty of establishing the criteria by which the proteins are selected.

This paper was followed by one by Dr. A. Neuberger upon the modern development of structural protein chemistry. Dr. Neuberger pointed out that during the period up to 1914, the structures of most amino-acids were determined, the presence of polypeptide chains in proteins was demonstrated and methods for the synthesis of peptides developed; the period between the two World Wars saw the introduction of physical methods into the field of protein chemistry. The molecular size and shape of many proteins were determined and the effect of electrostatic factors appreciated. Electrophoresis and potentiometric titrations gave a lot of new information about charged groups in proteins, and the multipolar character of proteins even in the isoelectric state was recognized. Dr. Neuberger then discussed some of the problems facing protein chemists at the present time. He explained that the resonance of the amide group is probably connected with the ability of peptide bonds to form hydrogen bonds, and that this resonance is likely to vary to some extent with the molecular environment of the bond in question and with the character of the side-chains. Attention was directed to modern work showing that bonds or forces other than amide bonds must be responsible for holding polypeptide chains together to produce the specific configuration of the native protein molecule. Weak covalent bonds of unknown type may be involved, but their presence or absence is difficult to prove. Hydrogen bonds and other electrostatic forces are likely to be responsible for the reversible association of some proteins, but the simple picture of salt linkages is not acceptable. Finally, Dr. Neuberger emphasized the importance of steric factors.

This session of the symposium ended with a paper by Dr. G. R. Tristram in which he reviewed methods of analysis other than chromatographic and microbiological techniques. He discussed ionophoresis, periodate oxidation, isotope dilution using stable and radioactive elements, and enzymatic methods which rely upon the use of specific enzymes. He then discussed with illustrative data the criteria suggested for the establishment of the accuracy and specificity of any method and the limitations imposed upon the interpretation of amino-acid data by the accuracy of the analysis.

The afternoon of September 29 was given over to an exhibition, held in the Physical Chemical Laboratory at the Imperial College of Science and Technology. The exhibits covered equipments and techniques employed in amino-acid analysis and the determination of nitrogen balance, electron micrographs, commercial syntheses of amino-acids, the commercial manufacture of protein hydrolysates, the amino-acid – sugar reaction responsible for the deterioration of food products and the Craig–Post apparatus for counter-current extraction on a preparative scale.

The first two papers of the evening session of September 29 dealt with amino-acid analysis. The first paper, by Dr. E. C. Barton-Wright, reviewed the microbiological methods of assay, while the second paper, by Dr. R. L. M. Synge, discussed chromatographic methods. Dr. Barton-Wright described the basic technique of the microbiological method of amino-acid assay and then discussed in some detail the composition of the basal media and the stimulatory effect of some amino-acids. The statistical treatment of response curves by the log/log relationship was described, and advantages of the microbiological techniques over chemical methods were reviewed.

Dr. Synge described different chromatographic procedures involving ion exchange and molecular adsorption or partition between liquid phases, and discussed various analytical problems in which chromatographic methods have been especially useful. He also explained how the techniques selected should be governed by the purpose of the analysis since, for example, the rapid analysis of foodstuffs and the

removal of interfering amino-acids by stripping require different approaches.

Dr. C. H. Lea gave the final paper of this session, and of the first day of the symposium; he considered the role of amino-acids in the deterioration of food. He explained how a reaction between amino-acids and reducing sugars is responsible for deteriorative changes in flavour, colour, solubility and other properties in a wide variety of foodstuffs, and he reviewed the effect of humidity and temperature on these changes. He reported that reaction occurs with various amino-acid side-chains, including arginine, histidine, tyrosine and methionine, but that the combination would seem to involve something more than *N*-glycoside formation.

The morning session of September 30 was devoted to only two papers. The opening paper, by Dr. C. Ockrent and colleagues, dealt with the manufacture of amino-acids. Having reviewed the many uses of amino-acids, Dr. Ockrent explained that the optically active L-isomers are obtained commercially by separating them from the acid or enzymic hydrolysate of proteins, while the racemic DL-forms are manufactured synthetically. Examples were given of the separation of individual optically active amino-acids involving the use respectively of flavianic acid, picric acid and copper carbonate, and then Dr. Ockrent concentrated upon methods of synthesis. He discussed, with the aid of slides showing each step of the reactions, a series of commercially applicable methods of synthesis and a few methods mainly of academic interest.

This paper was followed by one by Dr. S. M. Partridge upon the use of displacement chromatography as a preparative method for amino-acids. Dr. Partridge described the use of columns of synthetic resinous ion exchangers for the separation of amino-acid mixtures, and explained how fractionation can be accomplished by displacement from a cation-exchange resin with a strong base. He described with the aid of slides an apparatus for the automatic collection of fractions from a displacement experiment, and showed how the purity of each collected fraction can be determined by paper chromatography.

The first of the two papers presented in the afternoon of September 30, which was by Dr. G. M. Dyson and Mr. E. M. Bavin, was concerned with the manufacture of protein hydrolysates. Dr. Dyson first discussed the consideration which decides the choice of protein material, and then explained that the main problems associated with large-scale manufacture are the elimination of pyrogens, the elimination of pressor and depressor substances, adequate hydrolysis of the protein and prevention of tyrosine deposition. He explained the various factors which influence these problems, and the steps taken to ensure that they are adequately dealt with. Dr. Dyson then gave a detailed description of the plant and process employed in large-scale production of protein hydrolysates, and discussed the rigorous control tests to which they are subjected.

Dr. Dyson's paper was followed by one from Dr. H. G. Rees upon the application of amino-acids and protein hydrolysates in the food industry. In this paper the methods available for the preparation of hydrolysed products for the flavouring of foods were considered. Dr. Rees then dealt more specifically with the use of monosodium glutamate as a food adjunct and discussed the history of this product and modern methods of manufacture.

The final session of the symposium was devoted to an address by Dr. D. P. Cuthbertson on amino-acids and protein hydrolysates in human and animal nutrition. Dr. Cuthbertson discussed in some detail the metabolism of proteins and amino-acids and then gave consideration to protein requirements in health and convalescence, protein insufficiency and the effects of trauma and infection. He stressed that dietary surveys conducted in temperate regions indicate that, at all ages from one year onwards and at all energy-levels, the protein intake expressed as a percentage of total calories is reasonably constant at 11–14 per cent. In a following section of his paper, Dr. Cuthbertson discussed the use of protein hydrolysates by intravenous injection and by tube into the alimentary canal, and summed up by saying that there is no solid evidence that there is any special value to be derived from such procedures. Dr. Cuthbertson also mentioned the subject of infusing sufficient protein (and energy) by intravenous injection, and suggested that the necessary indications for parenteral feeding are inability to ingest, digest or absorb adequate quantities of food over such a period of time as would jeopardize convalescence or even the chance of survival.

EFFECT OF LOW FAT INTAKES AND OF CRUDE FIBRE ON THE ABSORPTION OF FAT

By Dr. A. R. P. WALKER

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IT is well known that fat is well absorbed by man when consumed in amounts of 50–150 gm. per day. Under these conditions, the apparent absorption of fat $\left(\frac{I-F}{I} \times 100\right.$, where I is intake of fat and F the amount excreted in the fæces) is more than 90 per cent, less than this proportion being considered pathological. When the intake of fat is relatively low, however, the apparent percentage absorption is greatly reduced (58–62 per cent)[1,2]. The purpose of this communication is to provide evidence that the fat which is excreted in the fæces, and which is assumed to be unabsorbed fat in calculating the apparent absorption, is mainly of non-dietary origin, and that the true absorption of fat is not necessarily lower when the intake of fat is reduced. The evidence, which is based on the study of diets of different fat and crude fibre contents, also indicates that the additional amount of fat which is excreted in the fæces when the fibre content of a diet is greatly increased[3] is not unabsorbed fat, but is probably wholly of endogenous origin.

Balance observations were carried out on a healthy European male subject of thirty-five years of age, over a period of 124 consecutive days. During this period the intake of fat was maintained at four different levels, ranging from 61 down to 3 gm. per day; the fibre intake was controlled to yield stools of different weight, the normal stool averaging 30–35 gm. dry fæces per day, the moderately large 40–45 gm., and the very large 60–70 gm. Each successive level of fat and fibre intake was given until the average amount of fæcal fat excreted daily remained

Table 1

Normal fibre intake period (30–35 gm. dry fæces daily)			Moderately large fibre intake period (40–45 gm. dry fæces daily)			Very large fibre intake period (60–70 gm. dry fæces daily)		
Fat intake (gm. daily)	Fat excretion (gm. daily)	Apparent % absorption	Fat intake (gm. daily)	Fat excretion (gm. daily)	Apparent % absorption	Fat intake (gm. daily)	Fat excretion (gm. daily)	Apparent % absorption
60·1	3·25	94·6	60·5	3·35	94·5	61·0	3·45	94·3
22·5	3·1	86·2				21·9	3·25	85·1
12·4	2·6	79·1				12·0	2·95	75·4
3·3	2·4	27·3	3·2	2·55	20·2	3·5	2·85	18·6

The term 'fat' includes the free fatty acids present together with those derived from the glycerol esters and soaps; the determinations were carried out using the method of van de Kamer[4].

constant; these periods ranged from seven to twenty-one days. It is important to emphasize that the diets were neither unusual nor synthetic, but were composed throughout of foodstuffs in common use. The results obtained are summarized in Table 1.

For the sake of brevity the above results and further experimental results are discussed under the following headings:

(1) *Effect of changes of fat intake on the excretion of fæcal fat.* Reducing the fat intake below 22 gm. per day caused a slight reduction in the amount of fæcal fat excreted. On the other hand, altering the intake from about 60 gm. to 22 gm. a day had practically no effect on the amount excreted; a similar conclusion has been reached by Annegers *et al.*[5], who found that, under their experimental conditions, with fat intakes of 93–168 gm. per day, the fæcal fat excretion was independent of dietary fat intake.

(2) *Apparent absorption of fat at low fat intakes.* The apparent absorption of fat decreased with decreasing intake, a finding which also appears to apply to protein[6]. In this study, almost all the individual fats consumed are known to be well absorbed normally. Unless, therefore, fat is less well absorbed with decreasing intake, a phenomenon unknown for any other nutrient so far as I am aware, the above results can only be explained on the basis that a high proportion of fæcal fat is of intestinal origin.

(3) *Effect of crude fibre on the absorption of fat.* When a large increase was made in the crude fibre content of the equal fat diets, the amount of fæcal fat excreted detectably increased. In the investigation of Macrae *et al.*[3], this increase was much more pronounced, for under somewhat similar dietetic conditions the average excretion of fæcal fat (ether soluble) increased from 2·7 to 4·7 gm. a day. The question arises as to whether the *additional* fæcal fat is unabsorbed fat or is of non-dietary origin. Although the apparent percentage absorption of fat was slightly reduced by the high fibre diet, such a diet does not appear to reduce the true absorption of nitrogen[6]. Furthermore, although the ingestion of fibre usually shortens the time of passage of material through the digestive tract, in an investigation on diarrhœic patients[7] the apparent absorption of fat was reported to have been excellent. These considerations suggest that the additional fæcal fat is perhaps wholly of non-dietary origin; and that the intake of fibre, when high, controls the amount of this fat excreted, just as it controls the excretion of non-dietary nitrogen in the fæces[6]. The present investigation supports this view, in that the capacity of the high-fibre diet to raise the fæcal fat excretion is just as marked at low intakes, when the unabsorbed portion would be expected to be small, as it is at higher intakes.

While this issue of whether the additional fat be composed of unabsorbed or of intestinal fat may seem somewhat academic, it has a bearing on communities, such as the South African Bantu, whose customary diet, mainly of high-extraction maize products and beans, is high in fibre yet low in fat. This may be appreciated from Table 2, which provides data on the fat metabolism of two healthy young Bantu male subjects, and of a young European male who consumed exclusively as much as possible of the Bantu diet for ten days.

The unusually high amounts of fæcal fat excreted daily, particularly with the Bantu subjects, can scarcely be attributed to the types of fat consumed, since the fats of maize and most legumes have been reported to be highly digestible[8,9,2]. Nor can they be ascribed to the laxative effect of the fibre intake, for when 50 gm. butter was added to the diet of the European, no increase in fæcal fat excretion was observed, showing that optimum conditions for fat absorption prevailed. It would seem reasonable to conclude that the bulk or perhaps the whole of this fæcal fat is of non-dietary origin.

Recently, McCance and associate workers[6,10] fed humans with diets composed almost exclusively of wheat and oats—diets very rich in fibre, which led to the voiding of enormous stools. The average amounts of fæcal fat excreted daily were found to be very high, and were attributed to the low digestibility of the cereal fats, which were reckoned as 58 and 68 per cent respectively. Since much the same phenomenon occurred with the two Bantu subjects, with their maize and beans diet, the fats of which are known to be highly digestible, the low apparent absorptions found by these workers would seem to be more readily explicable on the lines suggested above. An additional argument against accepting that wheat fat is poorly digested is found in the metabolism studies of Macrae *et al.*[3]; when their subjects' basal diet, containing 43 gm. fat (mainly margarine), was supplemented with white bread containing 13 gm. wheat fat, the total daily fæcal fat excretion amounted to only 2·7 gm.; a figure of 5–6 gm. would have been expected on the basis of the above workers' theory.

As to the source of these large amounts of non-dietary fat excreted, information is meagre. The fat may be derived from (1) intestinal secretions, pro-

Table 2

Subjects	Period of observation	Av. intake crude fibre (gm. daily)	Av. intake fat (gm. daily)	Av. weight dry fæces (gm. daily)	Av. weight fæcal fat (gm. daily)	Av. apparent % absorption
2 Bantu (average figures)	21 days	15·5	25·8	109	13·2	48·8
1 European	10 days	11·5	16·6	54	7·1	57·3

Fat data corrected for minute amounts of fat contained in incompletely chewed food recovered from the fæces.

duced perhaps by excessive peristalsis due to the passage of the large amount of fæcal matter; (2) fatty acids produced by bacterial action on cellulose; or (3) bacterial synthesis. The fat itself is largely 'true' fat, for McCance[6] found little unsaponifiable matter present; moreover, I have found fairly close agreement between the fat determination by the van de Kamer and ether extraction Soxhlet methods, indicating the proportion of sterols, phosphatides, etc., present, to be very low.

(4) *Differences in fæcal fat excretion shown by humans on a standard diet.* From Table 1 it will be observed that the long-term subject, in the normal fibre intake and 60 gm. fat intake period, excreted 3·25 gm. fat daily. On returning to this diet, at the end of the investigation, it was found that the fat excretion remained steady at 2·8 gm. The same subject showed a 35 per cent change in fat excretion in an interval of four years when consuming the same test diet. This shows that changes in excretion do occur, although the assumption that the amount of fæcal fat excreted remains constant under ordinary dietetic conditions[5] may well be true for short periods. Sperry[11] found that the excretion of intestinal fat on a fat-free diet varied from dog to dog, and also in the same dog. It is therefore suggested that the wide differences in fæcal fat excretion found among humans on a standard diet[5,12] are due to differences in the amount of non-dietary fat excreted, rather than to differences in the capacity to absorb food fat. Of the non-dietary factors influencing the amount of intestinal fat excreted, little is known, though the work of Shapiro *et al.*[13], using labelled fat, suggests that alterations in the flow of bile may be of some significance.

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NUFFIELD FOUNDATION

PROSPECT AND RETROSPECT

THE fourth report of the trustees of the Nuffield Foundation* marks the end of the first planned period of the Foundation's activities. That period covers six years, of which the first (1943–44) was devoted principally to devising the programme to be followed in the next five. During these six years the Foundation has allocated grants of £2,124,175 from a total income of £2,712,838, divided among five main fields: £591,397 for the medical sciences; £289,750 for the natural sciences; £172,750 for the social sciences; £464,628 for fellowships and scholarships; £545,770 for the care of old people, while £59,880 went for miscellaneous projects outside the main programme. The present report is of exceptional interest not only for its appraisal of every major grant made during the period and the setting out of the principles of policy that have guided the trustees in their choice of projects, but also for the indication of their aims during the next quinquennium.

One of the chief objectives is, indeed, to promote not only the better investigation of problems but also the better integration of divergent specialized studies. Briefly, the policy in the medical sciences has been to promote the proper understanding, definition and maintenance, with the principal exception of rheumatism, rather than to seek cures for established diseases; in the natural sciences, to increase the resources available to man by fundamental research in physics; in the social sciences, to assist the disinterested study of human society and of men in society; in fellowships, to train promising undergraduates for teaching and research in subjects related to the Foundation's special interests and to develop a traffic of senior students and eminent men within the Commonwealth; in the care of old people, to survey and make known the needs of our increasingly elderly population and to create means to meet those needs. In furthering research and education in the medical, natural and social sciences, the Foundation has sought to select and support projects at the growing-points of each of these groups, with the motive of advancing knowledge particularly in those fields which seemed likely to yield some real improvement in the conditions of human existence. Mainly fundamental research has been supported, and for the next quinquennium the Foundation hopes to devote most attention to the advancement of biological and sociological studies which may contribute to the promotion of human health and welfare. In the field of biology, the Foundation will particularly welcome opportunities of supporting such studies as may increase our knowledge of the normal mechanisms of growth, differentiation and self-maintenance of living things. In the social sciences it is specially interested in bringing the non-economic studies—such as social anthropology or sociology in the narrow technical sense—up to the level of the more developed subjects like economics, and in increasing the integration of the various specialized subjects. In both fields the Foundation is prepared to support work aiming at the extension and application of known, and the search for new, aids to investigation.

Schemes likely to increase the number of able research workers in these fields of study or which would free existing research workers from unduly hampering and distracting commitments will also be considered, and the Foundation will try to assemble groups of experts in various subjects who are prepared to work together on the elucidation, by existing knowledge, of practical problems of far-reaching importance. Schemes of training fellowships and other awards will be continued, and the Foundation, through the National Corporation for the Care of Old People, will continue to contribute to their better care and the better satisfaction of their needs within the community. The Oliver Bird Fund will be devoted to fundamental research into the cause and nature of the disease-process of chronic rheumatism, and to an attempt under scientifically controlled conditions to assess the various known methods of alleviation.

* Nuffield Foundation. Report of the Trustees for the Year ending 31 March, 1949. Pp. 128. (London: Nuffield Foundation, 12 Mecklenburgh Square.)

Reviewing the grants for the natural sciences, the report notes that a total of £193,000 has been offered to five university departments for the early rebuilding of vigorous research teams backed by skilled technical services. At Birmingham, under Prof. M. L. E. Oliphant, the grant of £25,000 over five years has helped the Department of Physics to develop a new type of accelerator for producing very energetic protons for research in nuclear physics and to design apparatus and experimental procedure for accurate observation of the scattering of these particles. A grant of £60,000 over six years to the University of Glasgow has led to the development under Prof. P. I. Dee of an active school of research in the Department of Natural Philosophy, where a 300-million volt synchrotron is being built and a 30-million volt synchrotron for high-energy gamma rays and a million-volt D.C. generator for the acceleration of protons and deuterons have been installed. A further £1,750 has been added to the original grant of £25,000 for the biomolecular research laboratory under Prof. J. D. Bernal at Birkbeck College, London, where promising results have already been obtained on the enzyme ribonuclease and the virus of turnip yellow disease. A fine-focus X-ray tube has been developed for the study of very small crystals of biological origin and the first stage of work on optical focusing of X-rays completed. Work financed by a grant of £64,000 over eight years to the Clarendon Laboratory, Oxford, on the properties of matter at the low temperatures obtainable with liquid helium has been of special interest in the development of the theory of liquids, and that on the thermal conductivity of glass has led to results of theoretical and practical importance.

Besides the work in metallurgy at the Cavendish Laboratory, Cambridge, under Dr. E. Orowan's fellowship, the Foundation, in co-operation with the Institution of Mining and Metallurgy, has offered £20,000 for the endowment of a team of research workers under a suitable leader. Under the grant of £10,000 for five years, two studies are in progress at Cambridge, into water-flow in soils and into the mechanics of soil disturbance by the passage of agricultural implements. The two new grants made during the year are £2,000 to the Department of Human Anatomy, Oxford, for optical equipment for research on the biological applications of the reflecting microscope and £1,000 for a pilot survey in the north of England and in Inverness to discover how much information can be obtained from past and current records at the blood-transfusion centres, how best to handle the material, what is the scientific value of the results, and how the present registers of donors could be modified to make them as useful as possible for research purposes.

Reviewing grants to the medical sciences, the report points out that the industrial health and rehabilitation service started at Slough two years ago is linked for the prosecution of research in occupational health with the Universities of Oxford and London, and it is this aspect of the service's work that the Foundation's grant of £15,000 over five years is intended to support. Ultimately the Slough service may demonstrate a model for any industrial health service for small factories which the Government may plan to supplement the National Health Service. Besides £31,000 for training fellowships and scholarships in dentistry, the Foundation has made grants totalling £90,000 to four university schools to improve the scientific quality of dental research and teaching. The student health survey at the Institute of Social Medicine, Oxford, for which £10,000 was provided, has already revealed the risk of infection from previously undiscovered cases of active pulmonary tuberculosis present in the student community. Under the grant of £100,000 over ten years to the University of Manchester for research in chronic rheumatism, the clinical side of the work is now fully organised, and clinical research includes a controlled study of the value of X-ray treatment in ankylosing spondylites, and a parallel series of injection treatments in rheumatoid arthritis. Physiological studies are concerned with the genesis of pain. A grant of up to £2,090 has been made to enable the rheumatic unit in the Department of Medicine, Edinburgh, to engage whole-time staff for therapeutic trials, and one of £3,832 to the University of Manchester for the investigation of nasal catarrh has indicated the importance of allergy as the cause of many chronic cases.

In the field of social sciences, a grant of £10,000 to the Department of Applied Economics, Cambridge, for five years from 1946 is being used for research fellowships, while £1,000 a year for three years has been offered to the International Association for Research in Income and Wealth. The grant of £3,000 a year to the National Institute of Economic and Social Research has been renewed for a further five years, and a further £5,000 has been offered for social as distinct from economic research. A new grant of £5,000 payable over four years was made to the Northern Industrial Group for the expansion of its social and economic research, and a geographer and an economist have already commenced a study of West Durham. A five-year grant amounting to £15,000 has been made to Political and Economic Planning for further pioneering in that field, while a grant of £25,000 to the Population Investigation Committee has enabled that Committee to conduct demographic studies in Great Britain and other countries and to initiate field-inquiries into the maternity services and into the trend of intelligence among Scottish children. A grant of £10,000 was made to the Institute of Advanced Legal Studies, London, for a Nuffield Library of British Commonwealth law books, and another of £10,000 to the Administrative Staff College to be used over five years for waiving fees in approved cases.

The medical fellowships scheme is to be continued into the second quinquennium; but the fellowships are now open to the whole field of medicine, though the bias towards social medicine, child health, industrial health and psychiatry remains. Four fellowships in chronic rheumatism have also been awarded. The dental fellowships scheme is also being continued in the second quinquennium and effect is being given to a scheme for the direct exchange of a few American and British medical and psychiatric social workers. The visits of the first panel of medical visitors to the Colonies have been completed and the panel chosen for the second year. During the year, with the help of the Foundation under the scheme of visiting lectureships, Dr. J. Hammond and Prof. D. M. S. Watson have visited South Africa; Sir John Cockcroft is visiting South Africa, and Prof. C. E. Tilley, New Zealand. The fellowship and scholarships scheme for the advancement of extraction metallurgy provides a two-way traffic throughout the Commonwealth and Empire, and there are also two main schemes for Dominion travelling fellowships open to Canada, Australia, South Africa and New Zealand. The grant

for research on ageing to the Department of Psychology, Cambridge, has been renewed for a further three years, and Dr. T. Howell's work on the pathology of ageing and especially investigations into the incidence and manifestations of chronic bronchitis have been assisted by grants totalling £2,300 over three years. Grants made before the formation of the National Corporation for the Care of Old People are reviewed, and of the Foundation's grant to the Corporation, £440,000 has been found from income to date and the remaining £60,000 will be provided from the income of the first two years of the quinquennium. A grant of £4,000 was made to defray the expenses of the official delegates to the inter-Commonwealth conference of universities, and grants totalling £14,000 for five years were offered to enable the Caldecott Community in Kent to open an experimental reception centre for homeless and insecure children, while £9,000 has been granted to the Commonwealth (Agricultural Bureaux) Potato Collection for new greenhouses and laboratory.

RESEARCH COUNCIL OF ALBERTA

ANNUAL REPORT FOR 1948

THE twenty-ninth annual report of the Research Council of Alberta for the year 1948* includes the customary list of members and of staff and of publications of the Council. The bituminous sand studies were prepared for publication; but the separation plant at Bitumount was not put into operation, and although further work was done on the role of bituminous sand in the hot-water separation process, the study of the applicability of the general method of water-flooding to recover oil from the bituminous sands has been concluded as of no practical value.

The chemical and physical survey of Alberta coals continued, and it has been observed that the capacity-moisture contents of Alberta coals appear to follow a step-wise course, as the carbon contents increase and the oxygen contents decrease from immature to mature coals. The principles of operation of the New Stansfield report for low-temperature carbonization of sub-bituminous coals have been established, and investigations have been started on the briquetting quality of local asphalts and on the production from slack coal of a product suitable in size and quality for domestic and industrial purposes without the use of pressure.

The scope of the Gasoline and Oil Testing Laboratory was broadened to include the analysis of all types of petroleum products except greases. In the geological field, the principal projects were a search for high-grade clays and a detailed survey of mineral resources in specific areas with emphasis on water supply. A systematic study was made of soil conditions and the densities secured with the construction procedures being used on three new highway jobs.

Testing of catalysts for use in the synthesis of liquid fuels from carbon monoxide and hydrogen was discontinued in May 1948; but the Council will keep in touch with work being done elsewhere on the Bergius and the Fischer–Tropsch processes and on the gasification of coal for the synthesis process. A study of under-employment in the Alberta coal industry was commenced in May 1948, the soil survey of the Peace River district was continued and also the physical and chemical studies of wheat and oat straws; while the investigation of industrial processes that may be suitable for introduction into Alberta continues to be an important feature of the work of the Council.

* Research Council of Alberta. Report No. 54: Twenty-ninth Annual Report of the Research Council of Alberta, 1948. Pp. 27. (Edmonton, Alba.: King's Printer, 1949.)

RECENT EARTHQUAKES

DURING the period June 1–September 30 there were about forty major earthquakes, 140 moderate ones and some minor activity. The two greatest shocks during the period were probably those on July 10 in eastern Turkestan and on August 22 off British Columbia. Both reached instrumental magnitude 8. The former took place at 03h. 53m. 36s., G.M.T., from a focus with epicentre near lat. 39° N., long. 71° E., and was followed on the same day by four strong aftershocks and two moderate ones. The latter, at 04h. 01m. 12s., G.M.T., on August 22, took place from a focus with epicentre near lat. 54° N., long. 133° W., and was felt over a wide area in British Columbia. Minor damage was done. The earthquake caused a seismic sea-wave or *tsunami* which attained a height of two feet at Ketchican, Alaska, and for this earthquake the Hawaiian seismic sea-wave warning service was brought into operation (see *Nature*, October 1, p. 560). The shock of deepest focus for the month happened on June 12 from a focus 600 km. deep with epicentre near lat. 27° S., long. 64° W., in northern Argentina. An aftershock the next day with the same epicentre took place from the same depth of focus.

An earthquake on July 23 from a focus with epicentre near lat. 38·5° N., long. 26·5° E., near the west coast of Turkey was destructive in Izmir and Karaburin and in the island of Chios. In Chios four people were reported killed, fifty injured and more than two hundred houses destroyed. The shock attained instrumental magnitude 7. The earthquake in central Ecuador on August 5 (see *Nature*, August 13, p. 266) attained instrumental magnitude 7. On August 17 an earthquake with instrumental magnitude 6½, having an epicentre near lat. 39° N., long. 40° E., caused the deaths of 320 people, chiefly in the districts of Karliova and Bingol in north-eastern Anatolia.

In England on June 23 at about 8.14 p.m. and again at about 10.14 p.m., British Summer Time, the inhabitants of the districts around Queen's Cross, Dudley, Brierley Hill, Stourbridge and Wolverhampton felt earth tremors which were also recorded on the seismograph at Hagley belonging to Mr. H. V. Shaw.

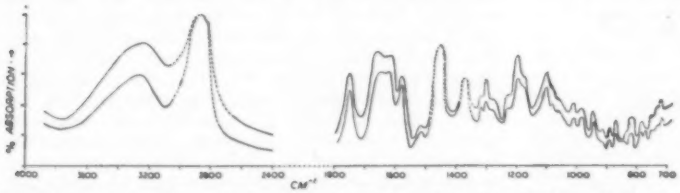
Readings from seismograms have been received from the United States Coast and Geodetic Survey in co-operation with Science Service, the Jesuit Seismological Association (St. Louis, U.S.A.), Strasbourg and Zurich, and also from individual stations at Aberdeen, Belgrade, Cleveland (Ohio), De Bilt (Netherlands), Durham, Edinburgh, Kew, Stuttgart and Toledo.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Actinomycin

THE name 'actinomycin' was given by Waksman and Woodruff[1] to a bright red crystalline antibiotic which they isolated from *Actinomyces antibioticus*. A preliminary examination of its chemical nature was made by Waksman and Tishler[2], who reported that it decomposed at 250°, had $[\alpha]_D^{25} = -320° \pm 5°$, and gave analytical values approximating to a formula $C_{41}H_{66}O_{11}N_8$; molecular weight determinations gave values varying from 768 to 1,000. Actinomycin appeared to contain a quinonoid system, since it underwent reversible reduction with hydrosulphite and it could be both acetylated and reductively acetylated. More recently, red antibiotic substances have been isolated from other Actinomycetes, and all have been considered to be identical with actinomycin[3]. It would also seem that the yellow xanthomycins[4] are related chemically to actinomycin.



Infra-red spectra of actinomycin (upper curve) and 'Antibiotic *X*.45' (lower curve). Samples in nujol suspension

We are at present investigating a bright red crystalline antibiotic isolated from an unidentified strain of Actinomycete by Lehr and Berger[5], and kindly supplied to us under the name 'Antibiotic *X*.45' through the courtesy of Dr. J. A. Aeschlimann of Hoffmann-La Roche, Inc., Nutley, New Jersey. This material is optically active ($[\alpha]_D^{25} = -332°$; *c*, 0·25 in ethanol) and decomposes at 252°. In ultra-violet absorption, toxicity and bacteriological spectrum, it is indistinguishable from actinomycin, and comparison of its infra-red absorption spectrum with that of a small sample of actinomycin generously provided by Dr. Waksman reveals only minor differences (we are indebted to Dr. G. B. B. M. Sutherland and Mr. T. S. Robinson for the determination of these spectra); the chemical properties of the two materials are indistinguishable. Our material, however, gives analytical values (C, 58·0, 57·8, 58·1; H, 6·5, 6·4, 6·4; N, 13·1, 12·9, 13·1 per cent) corresponding to an approximate formula $C_{41}H_{51}O_{12}N_8$ containing four active hydrogen atoms. Although the discrepancy between the analytical values is disturbing, the remarkable degree of coincidence in chemical and physical properties, and in particular the close similarity of the infra-red spectra, make it appear probable that actinomycin and 'Antibiotic *X*.45' are identical, though final confirmation of this point must await further work.

On mild acid hydrolysis a guanidino group is set free (positive Sakaguchi reaction) and a strong fatty acid odour becomes evident. On complete acid hydrolysis followed by paper chromatography, the presence is revealed in the hydrolysate of five substances which react with ninhydrin. Three of these, *A*, *B* and *C*, were quickly identified as the amino-acids threonine, proline and valine. The fourth substance, *D*, travelled somewhat faster than valine on paper strips developed with butanol–acetic acid or phenol; it did not appear as a coloured spot on such strips when ninhydrin development was carried out at 70° but came up strongly above 100°. Substance *D* was finally identified as N-methylvaline, an amino-acid which has also been found in *Fusarium* antibiotics[6]. The fifth substance, *E*, although probably an amino-acid, differs from all normally occurring members of this group and has not yet been identified. It has an R_f value in butanol–acetic acid closely similar to that of threonine, and in phenol to that of valine. On changing from an ammonia to an acid atmosphere in phenol chromatograms, substance *E* is held back slightly more than the other four amino-acids, but it does not appear to be a basic amino-acid and is not precipitated by phosphotungstic acid. Hydrolysis of Dr. Waksman's actinomycin under the same conditions yielded the same five ninhydrin-reacting substances.

Alkaline decomposition of the precipitate obtained by treating the crude acid hydrolysate of '*X*.45' with phosphotungstic acid yielded ammonia (from the guanido group) and suggested that a further base may be present. This is not identical with ethanolamine, which it resembles in smell.

Experiments with D-amino-acid oxidase result in complete removal of valine (we are indebted to Mr. K. Burton for assistance in the enzymatic experiments, and for providing the enzyme). The valine must therefore be D-valine, and the proline must be L-proline. Threonine is too slowly attacked to give significant results by this method, and experiments showed that the same applies to N-methylvaline. Preliminary experiments on partial hydrolysates have revealed the sequence threonyl–proline.

The four amino-acids already identified, assuming they are all present in peptide combination, account for $C_{26}H_{34}O_8N_4$. The association of a peptide with a quinone system is, so far as we are aware, unique among natural products. Further work on this material is continuing, and will be published in full elsewhere.

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University Chemical Laboratory,
Cambridge. July 30.

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Inflammation of Explosive Vapours and the Influence of Inert Diluents

STUDIES of the initiation of explosion in liquids detonated by light impact[1,2,3] and experiments with greatly diluted vapours[4] led to an investigation of the inflammation of some alkyl nitrates in the gas phase and of the influence of different diluents. The

compounds investigated were methyl nitrate, ethyl nitrate and nitroglycerol.

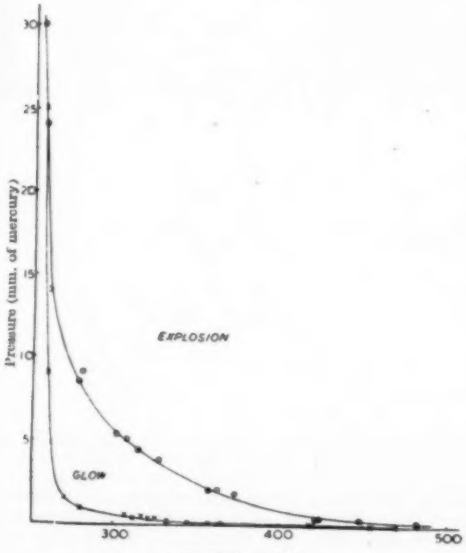
The explosion and thermal decomposition of methyl nitrate have been examined by Appin, Chariton and Todes[5], and in their account of the thermal decomposition of ethyl nitrate, Bawn and Adams[6] mention limiting conditions of pressure and temperature above which explosion occurs. The critical pressure limit above which the decomposition of methyl nitrate vapour in a quartz vessel becomes explosive has now been measured over a temperature range 240–500° C. (see graph). The higher the temperature, the more readily explosion occurred; a brief induction period preceded the ignition. Slight numerical differences between these results and those of Appin *et al.*, who conclude that the explosion is a thermal one, are due to differences in the geometry of the vessels and in the nature of the surfaces.

The effect of inert added gases on this explosion has been examined. It is found that argon and nitrogen both facilitate explosion. In the presence of oxygen, explosive combustion occurred at an even lower partial pressure of methyl nitrate. These results (Table 1) suggest a radical chain mechanism in which self-heating is of secondary importance.

Table 1. Partial pressure of methyl nitrate required for explosion (mm. mercury)

Temperature ° C.	Pure methyl nitrate	50% argon	50% oxygen
300	5·8	4·8	3·3
325	3·7	3·0	2·2
350	2·4	2·1	1·6

Careful examination of the behaviour of the pure methyl nitrate vapour revealed a new process in the decomposition. Under conditions too mild for explosion, a faint, transient glow, sometimes lasting several seconds, could be observed when the vapour was admitted to the vessel. The pressure limit of the glow lay below that of explosion (see graph). When explosion occurred, the faint glow always preceded the brilliant flash accompanying the explosion itself.



Inflammation of methyl nitrate vapour

Ethyl nitrate vapour behaved similarly; its glow limit lay below that of methyl nitrate, in accord with its greater rate of thermal decomposition.

Dilution with the inert gases argon and nitrogen facilitated the glow of methyl and ethyl nitrates (Table 2), especially at the higher temperatures, where it was possible to observe glows even in million-fold diluted mixtures, when the partial pressure of vapour was extremely small. Oxygen was less efficient than nitrogen or argon in facilitating the glow, and this difference was more marked at higher dilutions.

Table 2. Glow limit of methyl nitrate – nitrogen mixtures at 425° C.

Relative concentration of methyl nitrate	Pure	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}
Partial pressure (mm. mercury) required for glow	0·063	0·016	0·0045	0·001	0·0005	~0·0007	~0·00001

Values for dilutions greater than 10^4 are not very reproducible.

Nitroglycerol vapour (partial pressure 10^{-3} mm.) when diluted with 10 cm. of argon also glowed in the same way[4].

The inflammation of the alkyl nitrates is clearly a complex process. The glow may be connected with the production of excited formaldehyde molecules during the decomposition. These have a relatively long life and are not easily deactivated by inert gases[7]. It is possible that the inert gases facilitate the glow by maintaining the rate of activation of the methyl nitrate[8]; their effect on the explosion limit, on the other hand, shows that the explosion is not thermal but develops by a free radical mechanism.

We thank Dr. G. H. N. Chamberlain and Dr. A. D. Walsh for their kindness in helping us with some preliminary experiments in April 1947 on the explosion of methyl nitrate. We also thank the Ministry of Supply (Air) for grants to the Laboratory.

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Department of Physical Chemistry,
Cambridge. June 14.

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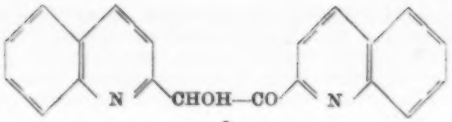
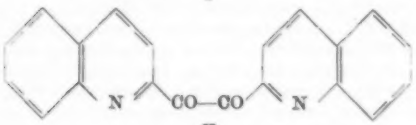
A New Cyclic Meso-Ionic Compound

BY the action of potassium cyanide on quinoline-α-aldehyde, Henze[1] obtained a crystalline product, m.p. 261°, which he assumed was the normal benzoin type of compound, namely, quinaldoin (I). Kaplan[2] confirmed this experimental work, but recorded no chemical properties of the compound.

We have found that the decarboxylation of quinaldinic acid in quinoline-α-aldehyde does not yield the expected αα′-diquinolylcarbinol. The product crystallizes from pyridine as almost colourless needles, m.p. 266–267° (found: C, 76·9; H, 4·0; N, 9·2; calc. for $C_{20}H_{12}O_2N_2$: C, 76·9; H, 3·85; N, 9·0 per



I



II

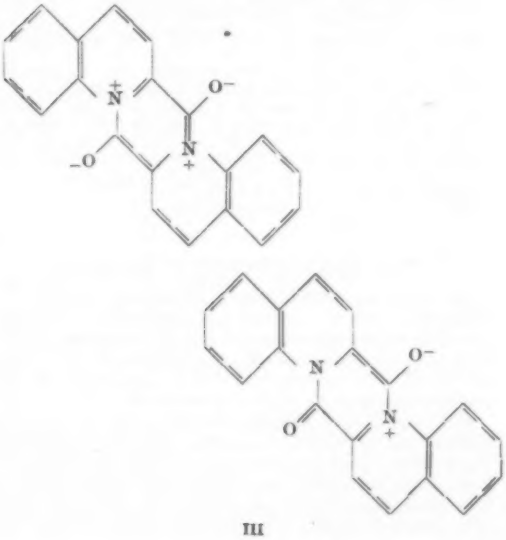
cent). This compound, which is also produced by the action of decarboxylating picolinic acid on quinoline-α-aldehyde, has been shown to be identical with the compound resulting from the action of potassium cyanide on the α-aldehyde. Thus arises a further example of the analogous behaviour of the α-pyridyl and α-quinolyl anions and the cyanide ion[3,4].

Linsker and Evans[5] claim to have prepared quinaldoin (I) and quinaldil (II) by the action of selenium dioxide on quinaldine. Their products have chemical properties in accord with these formulæ, and differ considerably from our product.

Moreover, the physical properties of the compound (high melting point and extreme insolubility in common solvents) indicate that it has an anomalous structure. The loss of two hydrogen atoms during its formation from quinoline-α-aldehyde,

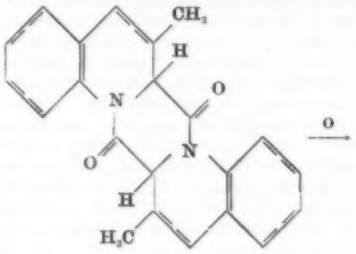
$$2C_{10}H_7ON = C_{20}H_{12}O_2N_2 + 2H,$$

is confirmed by the simultaneous reduction of methylene blue which occurs. Oxidation with hot permanganate yields 77 per cent of quinaldinic acid. The compound does not exhibit the properties associated with carbon–carbon double bonds, hydroxyl groups or carbonyl groups. Concentrated alkali causes the production of quinaldinic acid (60 per cent) with simultaneous reduction of methylene blue. On boiling with aniline a similar oxidative reaction takes place with production of the anilide of quinaldinic acid, not a Schiff's base.

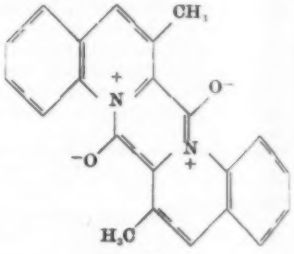


III

These properties, together with the experiments of Linsker and Evans[5], leave little doubt that the compound is neither quinaldoin (I) nor quinaldil (II). We suggest that the compound has a meso-ionic structure[6] involving resonance of hybrids of the type shown in

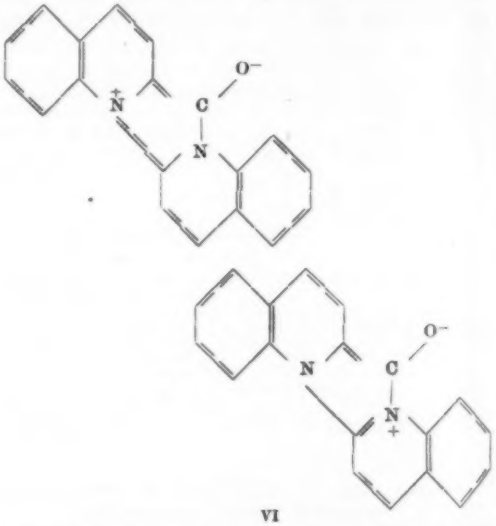


IV



V

(III). This formula accounts for the properties of the compound, especially the oxidative hydrolysis, since the hybrid has the form of a hydroquinone ion. Hydroquinones are known to undergo autoxidation in alkaline solution with production of quinones. In this case the resulting quinone is an acyl quinolinium hydroxide, hence its ready hydrolysis.



VI

The action of potassium cyanide on β-methylquinoline-α-aldehyde yields colourless rectangular prisms, m.p. 154–155° (found: C, 77·65; H, 5·45. $C_{22}H_{16}O_2N_2$ requires C, 77·2; H, 5·25 per cent). This compound is readily oxidized in air (with or

without methylene blue as oxygen carrier), yielding slightly brown needles, m.p. 220–221° (found: C, 77·4; H, 4·8; $C_{22}H_{16}O_2N_2$ requires C, 77·6; H, 4·7 per cent). Neither compound exhibits the properties of a ketone. The low melting compound has been formulated as a dihydro derivative (IV) of the compound (V), which is the β-methyl homologue of (III).

We should like to direct attention to the fact that Krollpfeiffer and Schneider[7] in 1937 proposed a mesoionic formula (VI) for the dyestuff Besthorn's Red. This highly coloured compound provides an interesting contrast with our colourless compound. The difference in colour is probably to be associated with the fact that the hybridization of Besthorn's Red involves the shift of a positive charge, whereas that of the other compound involves no such shift.

Details of this work, which is being extended in the hope of achieving an unambiguous synthesis of the compound, will be published later.

B. R. Brown
D. Ll. Hammick

Dyson Perrins Laboratory,
University of Oxford. May 25.

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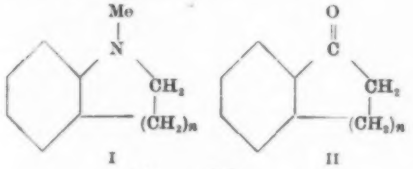
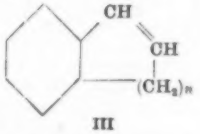
Resonance and Intramolecular Configuration

A COMPARISON of the absorption spectra of I ($n = 1$, 2 and 3 respectively) is cited as evidence that the steric requirements of the seven-membered ring ($n = 3$) impose a non-planar configuration which obstructs conjugation of the nitrogen atom with the benzene ring[1]. We wish to make it clear that although the seven-membered ring is puckered and can allow rotation of the group *Me*—N—CH_2— from the plane of the benzene ring, there is little reliable evidence that it enforces a rotation which effectively curtails the resonance energy which, apart from that in the benzene ring, is estimated to be 6 kcal.[2].



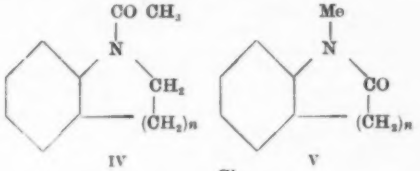
I II



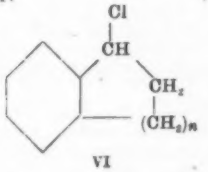
III

Conjugation of a carbonyl group with a benzene ring provides a resonance energy of 7 kcal.[2], and a study of the chemical and physical properties of the ketones II ($n = 1$, 2 and 3 respectively) and of some of their derivatives reveals no obvious anomalies[3,4]. The hydrocarbons III ($n = 1$, 2 and 3 respectively) are particularly interesting. In the last one, $n = 3$, resonance requires all but one of the carbon atoms to lie in or near a common plane, and it is remarkable that the absorption spectra of these hydrocarbons show no marked dissimilarity[4,5]. The spectrum of neither I, II nor III, with $n = 3$ in each case, has the marked peculiarities which are observed when bulky *ortho* substituents hinder conjugation by preventing coplanarity of the significant groups. Apparently, the configurational requirements of a seven-membered ring do not, in the above instances, compete effectively with the resonance energy.

The low reactivity of I ($n = 3$) in the hydrogen-exchange reaction is also cited as evidence of the steric inhibition of resonance by the seven-membered ring[6]. We wish to emphasize that this reaction demonstrates the high reactivity when $n = 1$ or 2 rather than the low reactivity when $n = 3$. The amine is present in the reaction mixture as a cation in which conjugation of the nitrogen atom with the benzene ring is weak and in which, unless $n = 1$ or 2, the benzene ring and the carbon atoms of the group *Me*—$\overset{+}{N}H$—CH_2— need not simulate the coplanar structure which is a feature of the free amine and of the transition state of the exchange reaction. It is the fixation of a near-planar structure in the cation which induces a ready dissociation and a fast reaction when $n = 1$ or 2. Conjugation with the benzene ring is also weak in IV and V, and here again the substances with $n = 2$, in contrast to those with $n = 3$ and to N-methylacetanilide, display a surprising facility for electrophilic substitution in the benzene ring[4].



IV V



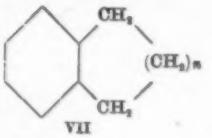
VI

Our argument is also supported by the rates of unimolecular hydrolysis and alcoholysis of the chloro compounds VI ($n = 1$, 2 and 3 respectively)[4]. Ionization is the rate-determining step, and provides a cation in which the group —$\overset{+}{C}H$—CH_2— is in the plane of the benzene ring. This configuration is maintained in the first two chloro compounds, and they are several hundred times more reactive than the third, which, in turn, is a little more reactive than α-phenylethylchloride.

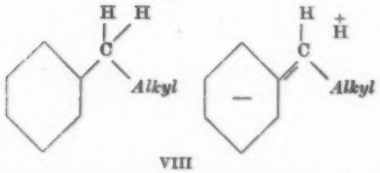
The above examples demonstrate that seven-membered rings provide no obvious anomalies when the resonance energy is large, and that five- and six-membered rings provide the anomalies when it is small.

The dependence of physical and chemical properties on intramolecular configuration provides valuable evidence of the delocalization of electrons, and we are studying the properties of the hydrocarbons VII ($n = 1$, 2 and 3 respectively) and of some of their derivatives, with the intention of clarifying the

Baker–Nathan effect. We deplore the present trend to employ formulæ of the type $H_3{\equiv}C{-}CH{=}CH_2$, and to neglect the geometrical requirements of hyperconjugation. We conclude by indicating a consequence of this shortcoming.



VII



VIII

Hyperconjugation occurs in the hydrocarbons VIII when the alkyl group (more correctly, the carbon atom which is directly attached to the benzyl group) is in or near the plane of the benzene ring. It is therefore susceptible to steric inhibition by repulsive forces between the alkyl group and the benzene ring, and, decreasing as the bulk of the alkyl group increases, becomes progressively smaller in each successive member of the series VIII (*Alkyl* = methyl, ethyl, *iso*-propyl and *tert.*-butyl). The rates of bromination of these hydrocarbons also decrease in this order, and had Berliner and Berliner fully appreciated the geometrical requirements of hyperconjugation, they would not have invoked a "second order hyperconjugation involving *beta* hydrogen atoms"[9].

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J. Chadwick
S. B. Rawlinson

College of Technology,
Manchester 1. June 13.

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Autoxidation of *Iso*propylbenzene

In view of current interest in the autoxidation of hydrocarbons, it seems desirable to record briefly some observations made in these laboratories concerning the autoxidation of *iso*propylbenzene.

Hock and Lang[1] had previously noted that dry *iso*propylbenzene was converted to a hydroperoxide (αα-dimethylbenzyl hydroperoxide) on being shaken in an atmosphere of oxygen at 85° C. and irradiated with ultra-violet light:

$$C_6H_5CH(CH_3)_2 + O_2 \rightarrow C_6H_5C(CH_3)_2OOH.$$

The rate of production of hydroperoxide was slow (about 0·3 mol. per cent per hour) and only limited conversions (about 7 per cent) of hydrocarbon to hydroperoxide were achieved.

During investigations started in 1945, we found that *iso*propylbenzene could be oxidized comparatively rapidly with oxygen in an alkaline oil-in-water emulsion at 85° C. to give the hydroperoxide in good yield. We believe that although the oxidation of organic compounds with air under alkaline conditions has been known for many years, the emulsion oxidation of a hydrocarbon to yield the hydroperoxide as major product is a novel technique. The method has also been applied to other aromatic hydrocarbons[2].

In a representative experiment, a 1 : 2 emulsion of purified *iso*propylbenzene in an alkaline (initial *p*H 10·5) aqueous phase containing 0·09 per cent w/v sodium stearate was stirred vigorously at 85° C. and oxygen passed through the mixture. After an induction period of 1·5 hr. absorption of oxygen commenced, the rate increasing with increasing hydroperoxide concentration up to a figure of 6·3 mol. oxygen per hour per 100 mol. *iso*propylbenzene after a total time of 14·5 hr. The concentration of peroxide (determined iodometrically in acetic acid under carbon dioxide) was 30 per cent molar, the efficiency of conversion of oxygen to hydroperoxide being 85 per cent. The product was then saturated with carbon dioxide and the hydrocarbon phase separated.

Isolation of the hydroperoxide from the oxidation products could be achieved by fractional distillation of the hydrocarbon phase under reduced pressure, preferably in the presence of a little solid sodium carbonate as stabilizer. In some cases the method of Hock and Lang (*loc. cit.*) was used, namely, the precipitation of the sodium salt with 25 per cent aqueous sodium hydroxide, and regeneration of the free hydroperoxide from its salt by treatment with acid. Quantitative recovery of the hydroperoxide was approached, however, only after several treatments of the hydrocarbon phase with alkali, since the free hydroperoxide is a very weak acid. Confirmation of the structure of the hydroperoxide was obtained by repeating the degradations described by Hock and Lang (*loc. cit.*), namely, by reduction with sodium sulphite or bisulphite to phenyl dimethyl carbinol, and by decomposition with 10 per cent sulphuric acid to phenol and acetone. Minor quantities of acetophenone, phenyl dimethyl carbinol and α-methylstyrene were identified during the working-up of our oxidation products.

This oxidation reaction is analogous to other radical chain autoxidations[3]. The induction period is eliminated by the addition of the hydroperoxide itself, or of other organic peroxides with a suitable decomposition-rate under the conditions of the autoxidation (for example, lauryl, benzoyl). Phenol inhibits the oxidation, and the reaction is sensitive to certain metals (lead and copper) which increase the rate of hydroperoxide decomposition. Beyond about 35 per cent conversion the oxidation-rate reaches a maximum, and thereafter declines. There is also a limit to the hydroperoxide concentration which can be achieved, this being of the order of 50 per cent molar.

More detailed investigations of the reaction have been made, including the effect of variations in the emulsifier, phase ratio, temperature and *p*H of the aqueous phase, and these will be published elsewhere.

We are indebted to the directors of the Distillers Company, Ltd., for permission to publish this letter.

G. P. Armstrong
R. H. Hall
D. C. Quin

Research and Development Department,
The Distillers Co., Ltd.,
Epsom, Surrey. June 15.

[1] Hock and Lang, *Ber.*, **77**, 257 (1944).
[2] The Distillers Co., Ltd., Hall and Quin, Brit. Pat. 610,293 (Oct. 15, 1948) and other applications pending.
[3] See, for example, Waters, *Ann. Reps. Chem. Soc.*, **42**, 136 (1945).

The Fischer Indole Synthesis

THE recently suggested theory of Pausacker and Schubert[1] involving free radicals in the Fischer indole synthesis appeared to us improbable. It seemed more likely that these experimental results could be explained quite readily by hydrolyses of the hydrazones and recombination to produce two new hydrazones. It may be remarked here that a fifth product, 1 : 8-dimethyl carbazole, should also have been isolated in small yield in the case quoted. The possibility that this is the correct interpretation is admitted by Pausacker in a second communication[2]. Evidence has now been obtained which shows clearly that it is the correct one, and that the free radical theory is untenable. The experimental results may be summarized as follows :

(1) Acetone phenylhydrazone (1 mol.), *cyclo*hexanone (1 mol.) for ½ hour, yield tetrahydrocarbazole (50 per cent).

(2) *Cyclo*hexanone 2 : 4-dinitrophenylhydrazone (1 mol.), phenylhydrazine (1 mol.) for 24 hours, yield tetrahydrocarbazole (18 per cent), 2 : 4-dinitrophenylhydrazine (31 per cent).

(3) *Cyclo*hexanone 2 : 4-dinitrophenylhydrazone (1 mol.), acetone phenylhydrazone (5·3 mol.) for 32 hours, yield tetrahydrocarbazole (16 per cent).

(4) Benzaldehyde phenylhydrazone (1 mol.), *cyclo*hexanone (1 mol.) for 25 hours, yield tetrahydrocarbazole (5 per cent).

All reactions were carried out in boiling glacial acetic acid. It will be recalled that under these conditions acetone phenylhydrazone and *cyclo*hexanone 2 : 4-dinitrophenylhydrazone do not cyclize. Experiments (1), (2) and (4) show clearly that hydrolysis and recombination to a new hydrazone occurred, and (3) is particularly significant in this respect. The isolation of dinitrophenylhydrazine in (2) excludes completely the possibility of a free radical mechanism. Moreover, the yields of tetrahydrocarbazole in each experiment are approximately those to be expected on the hydrolysis-recombination theory.

There still remains the possibility that the cyclization itself proceeds by a free-radical mechanism; but several strong arguments against this theory can be advanced. By careful working, a yield of more than 95 per cent of tetrahydrocarbazole can be obtained from the cyclization of *cyclo*hexanone phenylhydrazone by boiling glacial acetic acid. It is difficult to believe that this product would be formed in such high yield if free radicals were involved. Secondly, free $C_6H_5NH\cdot$ radicals would surely combine to give some hydrazobenzene, which under the reaction conditions would be converted to benzidine. Tests which detect 0·00003 gm. of benzidine gave negative results when applied to the appropriate fraction from the cyclization of 40 gm. of *cyclo*hexanone phenylhydrazone. Finally, any free radicals would be expected to react mainly with the solvent by the reaction

$$X\cdot + CH_3COOH \rightarrow CH_3COO\cdot + XH,$$

which would be followed by

$$CH_3COO\cdot \rightarrow CH_3\cdot + CO_2;$$

and hence large amounts of carbon dioxide should be liberated. It was found, however, that the yield of carbon dioxide was only 0·4 per cent. This probably arises from two other sources : (1) a small part coming from a side-reaction of unknown nature, since acetone phenylhydrazone slowly evolves carbon dioxide on boiling with glacial acetic acid, and (2) the major part from the thermal decomposition of acetic acid. The reasons for this suggestion are, first, that carbon dioxide is evolved rapidly just as the mixture reaches the boiling point, and secondly, the reaction is strongly exothermic and there may be present isolated points of high energy content.

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G. K. HUGHES
E. RITCHIE

School of Chemistry,
University of Sydney. June 16.

[1] *Nature*, **163**, 289 (1949).
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Shrinkage of Photographic Emulsions for Nuclear Research

THE photographic emulsions used for the recording of ionizing particles contain a very high ratio of silver halide to gelatin. This results in a considerable shrinkage of the emulsion at processing, due to the washing out of the silver halide. In order to be able to interpret correctly events occurring in the emulsion, or to measure accurately the lengths of tracks which have a large angle of dip, it is important to know the exact relationship between the orientation of the track in the processed emulsion and the path of the particle while passing through the plate. This relationship is usually given by the so-called shrinkage factor S, which is the ratio of the thickness of the emulsion at exposure to that after processing; it can be determined either directly, by measuring the thicknesses of processed and unprocessed strips of emulsion, or by observations on tracks of known angle of dip[1] or known length[2]. The usual way to correct for shrinkage is to multiply the vertical projection of the track-length by the shrinkage factor. This is based on the assumption that the shrinkage affects all tracks in a uniform manner; but this is not immediately obvious, owing to the complicated phenomena which occur at processing. Taking into account that the photographic emulsion technique is becoming a method of high precision, it was thought worth while to study the shrinkage problem in greater detail.

First we determined the shrinkage factor, by direct measurement of thicknesses, in various types of emulsions with different loadings, concentrations of gelatin, thicknesses, and under different conditions of development, fixing and washing. Our results show that the shrinkage factor roughly follows, although is always smaller than, the ratio of the total volume of the emulsion to that of the gelatin. For emulsions of normal composition we found that Ilford *C*.2, *E*.1, *G*.5 and Kodak *NT*-1*a*, *NT*-2*a* and *NT*-4 emulsions give nearly the same shrinkage factor, namely, $S = 2{\cdot}7 \pm 0{\cdot}2$, the limits being extreme values and including measurements on emulsions from different batches. For lithium-loaded emulsions S may go up to 3·2, due to the washing out of the lithium sulphate. We have also found that increasing the strength of the developer, or the time of fixation or washing, increases the shrinkage factor; but the changes in S are less than 10 per cent even for wide variations of processing conditions.

Our main aim was to determine whether the shrinkage is uniform throughout the depth of the emulsion, and whether the same correction can be applied to all angles of dip. For this purpose we used mainly lithium-loaded emulsions (Ilford *C*.2 and *E*.1), which we exposed to a flux of thermal neutrons. In

the unprocessed emulsion the $H^3 + \alpha$ tracks, resulting from the disintegration of lithium, should all have the same total lengths and be orientated at random. The effect of shrinkage can then be determined in two ways: by observing the angular distribution of the tracks in the emulsion, and by measuring the horizontal and vertical projections of the individual tracks.

In Fig. 1, which shows the result of one series of observations, the number of tracks of a given angle of dip is plotted against that angle. The full curve is that calculated for a random distribution, modified by taking into account the directly measured shrinkage factor. The agreement is seen to be very good, although the observations at large angles are not very reliable owing to the escape of tracks from the emulsion. These results refer to tracks in the whole emulsion; but we have also measured the angular distribution separately for tracks starting in various layers in the 200-μ thickness of the emulsion; for uniformly loaded emulsions we obtained identical distributions for the different layers. These results show that the shrinkage of the emulsion is uniform throughout its depth and that the directly measured shrinkage factor can be used for the correction for shrinkage, at least for small angles of dip.

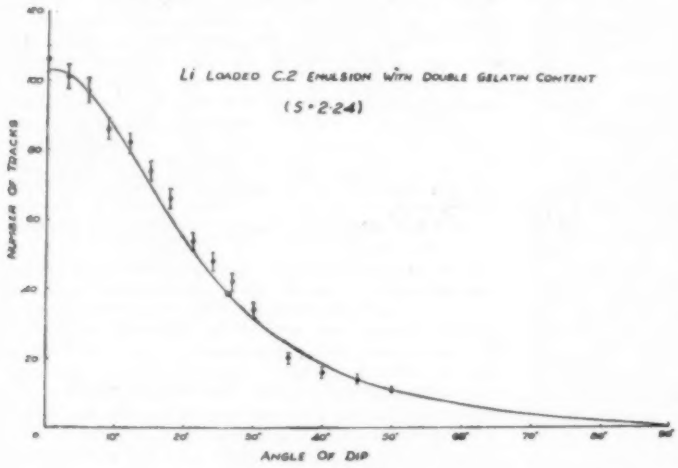

Fig. 1

In order to observe the effect on large angles of dip, we employed the second method, in which the horizontal (x) and vertical (z) components of each track were measured for various angles of dip. Typical results are shown on Fig. 2, in which the total length of each track, calculated from the formula $R = (x^2 + S^2z^2)^{1/2}$, is plotted against the angle of dip. The lower graph was obtained for a lithium-loaded $E.1$ emulsion of normal composition, and the upper graph for a $C.2$ emulsion with double gelatin content. As is seen, R is constant up to a certain angle of dip,

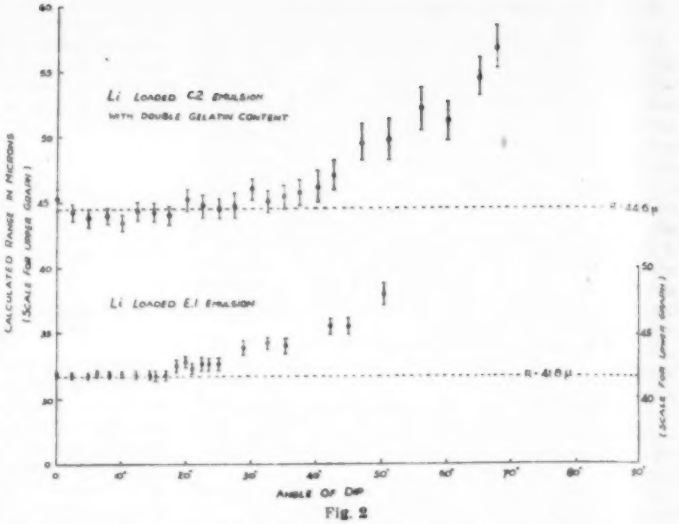

Fig. 2

but for larger angles R increases, which indicates that the shrinkage factor for the track is smaller than that corresponding to the emulsion. Similar results were obtained with alpha-particles from thorium C′ in plates impregnated with thorium (B + C). The angle at which the value of R begins to deviate is related to the spacing of the grains in the track, that is, it increases with the grain spacing. This phenomenon can probably be explained in the following way. As the emulsion shrinks in the vertical direction, the grains in a dipped track, initially separated, come closer together until they touch. The interaction between the grains will then prevent them from following further the displacement of the surrounding gelatin, and the track will consequently show a larger angle of dip than is expected from the shrinkage of the emulsion. Approximate calculations show that the deviation, indeed, occurs when the spacing between the grains is reduced to zero. Supporting evidence of this effect is given by the buckling of dipped tracks of heavily ionizing particles, which have a characteristic zig-zag appearance.

This result shows that the usual method of correcting for shrinkage, by multiplying the depth measurement by the shrinkage factor, is permissible only for angles of dip up to 25–30° in the case of heavily ionizing particles. For larger angles a smaller correction has to be applied, its value depending on the grain spacing in the track of the particle.

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George Holt Physics Laboratories,
University of Liverpool. July 20.

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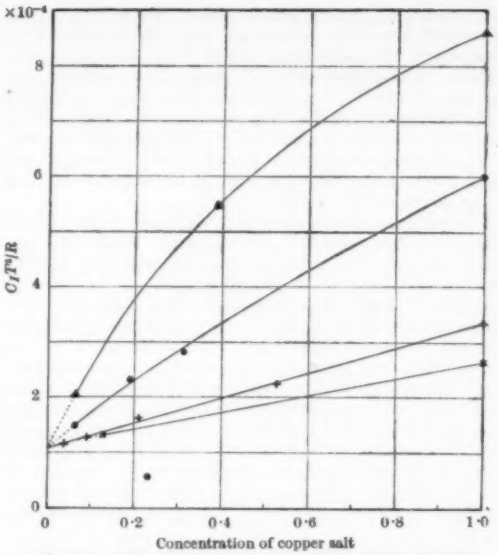
Nuclear Specific Heats of Copper Salts

GORTER[1] has suggested that, in salts containing ions which possess both an electronic and a nuclear magnetic moment, the coupling of the moments will be sufficient to allow of the alignment of the nuclear moments in a magnetic field of a few hundred gauss at temperatures of the order of 0·01° K. A further effect of this coupling will be a nuclear contribution to the specific heats of paramagnetic salts of which the ions possess a nuclear moment, for example, salts of cobalt, manganese or copper. Measurements of the specific heat of copper potassium sulphate below 1° K.[2,3] have shown that it is too large to be accounted for by magnetic dipole interaction alone. Garrett[4] has pointed out that taking Ritschl's[5] value of 0·022 cm.$^{-1}$ for the hyperfine structure splitting factor of the $^2d^9\ ^2D_{5/2}$ state of copper, the specific heat constant, CT^2/R, will be of the order 10^{-3}, which is sufficient to account for the observed specific heat of copper potassium sulphate. On the other hand, calculations based on Penrose's observation[6] of the hyperfine structure of the paramagnetic resonance spectrum of a highly diluted copper salt give an interval between the energy-levels of only 0·005 cm.$^{-1}$, and a specific heat constant of the order 10^{-4}.

We have investigated this question by measuring the magnetic susceptibilities and the specific heats of copper ammonium sulphate, copper potassium sulphate, copper rubidium sulphate, and copper cæsium sulphate, and also of the same salts diluted with the corresponding zinc salts. Our measurements have been made in the temperature range 1·0–4·2° K., in fields of 100–200 gauss, by the paramagnetic relaxation method[7], which measures the specific heat of the magnetic ions, excluding the salt's lattice specific heat. In copper salts, three factors contribute to this magnetic specific heat, namely, coupling of the magnetic ions by magnetic dipole interaction, coupling by exchange interaction, and the nuclear hyperfine splitting. At the temperatures we have used, all three factors give a specific heat inversely proportional to the square of the temperature, and cannot therefore be distinguished in measurements on the undiluted salts. As the salts are diluted with non-magnetic material, however, the first two effects are reduced, until at infinite dilution only the nuclear contribution remains. If we assume that the substitution of zinc ions for copper ions in the mixed crystal is random, and ignore co-operative effects, the specific heat per mole of copper will be linearly dependent on the concentration of copper.

The results obtained are shown in the accompanying diagram, in which the specific heat constant, CT^2/R, for a fixed mass of copper salt is plotted against the molar concentration of copper salt. It will be seen that though the specific heats of the undiluted salts differ considerably ($CT^2/R = 8{\cdot}7 \times 10^{-4}$ for copper ammonium sulphate, $6{\cdot}5 \times 10^{-4}$ for copper potassium sulphate, $3{\cdot}35 \times 10^{-4}$ for copper rubidium sulphate, and $2{\cdot}65 \times 10^{-4}$ for copper cæsium sulphate), the specific heats all approach values near $1{\cdot}1 \times 10^{-4}$ at zero concentration. The best results were obtained with the rubidium salts, where the dependence of specific heat on concentration was accurately linear. At zero concentration the specific heat constant is $(1{\cdot}1 \pm 0{\cdot}05) \times 10^{-4}$. The measurements on the other salts are less complete, but are consistent with the same or possibly a slightly higher value.



Specific heats of diluted copper salts; ▲—▲—, copper ammonium sulphate; ●—●—, copper potassium sulphate; +—+—, copper rubidium sulphate; ×—×—, copper cæsium sulphate

Taking $1{\cdot}1 \times 10^{-4}$ as the value of the nuclear specific heat constant, the heats of the undiluted salts can be analysed into their three components by calculating the magnetic dipole contribution to the specific heat by Van Vleck's method[8]. An approximate calculation gives values of the specific heat constant due to dipole interaction between $1{\cdot}3 \times 10^{-4}$ (ammonium salt) and $1{\cdot}2 \times 10^{-4}$ (cæsium salt). The contributions due to exchange are then $6{\cdot}3 \times 10^{-4}$ for copper ammonium sulphate, $3{\cdot}6 \times 10^{-4}$ for copper potassium sulphate, $0{\cdot}9 \times 10^{-4}$ for copper rubidium sulphate, and $0{\cdot}35 \times 10^{-4}$ for copper cæsium sulphate. The exchange effect is thus the largest contribution in the first two cases, but the smallest in the second two, in agreement with the qualitative evidence from the line breadth of the paramagnetic resonance spectra of these salts[9].

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Clarendon Laboratory,
Oxford. Aug. 4.

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Range–Energy Curve for α-Particles of about 2 MeV. Energy

IN a recent communication[1], Jesse and Sadauskis have proposed corrections to the Livingston and Holloway range–energy curves for α-particles[2]. The corrections are based on the assumption that ionization is proportional to energy for an α-particle in argon but not for an α-particle in air. It is claimed that this modified curve gives better agreement with

experimental results (for example, the B^{10} (n, α) Li^7 reaction) than the Livingston and Holloway curve. Although the published letter does not give any details of the comparison between the predicted and measured results, Dr. Jesse has very kindly sent this information privately. The agreement is very striking for the reactions considered, the differences between the energies obtained from the range–energy curve and those derived independently of ranges being less than 1 per cent of either.

However, there is one point which is not mentioned by Jesse and Sadauskis in their letter, but which has been pointed out by Gilbert[3]. In previous experiments the ranges in standard air of low-energy α-particles have been obtained from measurements, in some suitable gas, of the ranges of these particles and of polonium α-particles. The reduced range has been obtained from the measured ranges without any correction for the variation with velocity of the α-particle of the stopping power of the particular gas relative to air. For the B^{10} (n, α) Li^7 reaction, quoted by Jesse and Sadauskis in support of their proposals, the correction gives an increase of 8 per cent in the α-particle range, and is thus very important when considering modifications to the range–energy curve.

A further interesting feature of this particular reaction is that if the nuclear masses given by Bainbridge[4] are used to calculate the energies of the emitted α-particles, and these energies are used in conjunction with the corrected ranges to give points on the range–energy curve, then the agreement with the original Livingston and Bethe curves[5] is within the experimental error (2 per cent). We are at present attempting to improve the accuracy of measurement of the α-particle ranges in the boron reaction and also to check the magnitude of the stopping-power correction.

This result is, of course, in opposition to the proposals of Jesse and Sadauskis, and if substantiated suggests either that the nuclear masses are incorrect or that the assumption of proportionality between energy and ionization for α-particles in argon is not justified.

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Relative Yields of Ions Produced by α-Particles in Air and Water Vapour

In continuation[1] of the examination of the radiological properties of water, the yield of ion-pairs in water vapour under the action of α-particles has been compared with the yield in air. A sector-shaped parallel-plate ionization chamber containing either water vapour at 95° C. or air has been exposed to a semi-collimated beam of 5·0-MeV. α-particles derived from a polonium source. A low collecting field (about 50 volts/cm.) is sufficient to produce complete saturation in both gases at pressures of 10–20 cm. of mercury, and several determinations of the relative yield of ions[1] have been made. These have a mean value $\frac{I_{H_2O}}{I_{air}} = 1{\cdot}139 \pm 0{\cdot}006$. Making allowance for possible systematic errors, the corresponding ratio for the energy expenditure per ion pair is taken to be the reciprocal of this figure, $W_{H_2O} = 0{\cdot}878 \pm 0{\cdot}02$. If the value of W_{air} for 5-MeV. α-particles is $34{\cdot}7 \pm 0{\cdot}5$ eV.[2], the value for water vapour is therefore $W_{H_2O} = 30{\cdot}5 \pm 0{\cdot}8$ eV.

Further details of the experiments described above will be published elsewhere.

The assistance of a grant from the Medical Research Council is gratefully acknowledged.

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Multiplicity in the Hard Component of Cosmic Radiation Underground

In the course of experiments underground with the penetrating-burst apparatus described in a previous publication[1], we have obtained evidence for the production of groups of penetrating particles at a depth of 60 m. water-equivalent of London clay.

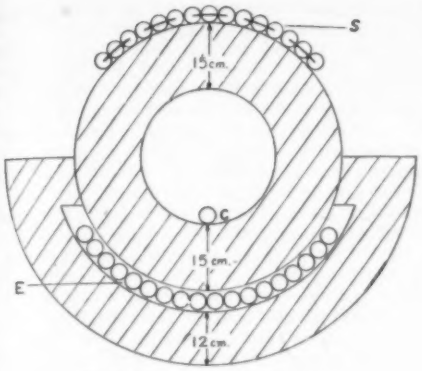
With this apparatus (see diagram), we recorded three-fold coincidences between any one of the fifteen counters S, counter C, and any one of the eighteen counters E. Pulses from the counters S and E were fed into a hodoscope unit, which indicated the individual counters discharged in bank E, and which of the five groups of three counters were discharged in bank S.

In 56 hr. 45 min. running time, we recorded 6,806 events, of which $3{\cdot}55 \pm 0{\cdot}22$ per cent indicated the discharge of two or more adjacent counters, and were attributed to knock-on showers accompanying the penetrating particle; a further $0{\cdot}9 \pm 0{\cdot}15$ per cent, however, could not be satisfactorily explained in this manner, as the separations of the counters discharged in bank E in these cases varied from one to eleven intervening undischarged counters, with a frequency-separation distribution showing only a slow decrease of frequency with increasing separation.

The above figures have been corrected by subtraction of the measured accidental coincidences.

Considering this result, we are inclined to advance the explanation that a process of production of groups of mesons by mesons is occurring. One may discount explanations based on nucleon primaries, in view of the thickness of earth above the apparatus; and from experiments we have performed with an ion chamber incorporated to select events accompanied by electron showers, we conclude that we may reject any possibility of an appreciable fraction of the coincidences being produced by low-energy photons[2]. Explanation of the process as the production of groups of mesons by mesons is supported by the experiments of Braddick and Hensby[3], who observed pairs of penetrating particles when operating a cloud chamber in this same underground laboratory.

Accepting this hypothesis of meson production by mesons, for which we calculate from our figures a cross-section of 5×10^{-28} cm.^{2}/nucleon, we may suppose the process to be the consequence of radiative



Shaded parts represent lead screens

collision of a meson with a nucleus in the absorber. Such a process would result in anomalous scatter of the primary meson, and presumably in a large proportion of cases the scattering nucleus would afterwards disintegrate. We may therefore compare our cross-section of 5×10^{-29} cm.^{2}/nucleon with the figure given by Wilson for large-angle scattering of mesons at sea-level[4] of 4×10^{-28} cm.^{2}/nucleon, and also with the figure of 5×10^{-29} cm.^{2}/nucleon obtained for star production in photographic plates exposed in this underground laboratory[5]. A more detailed account of these results and the work on penetrating bursts is shortly to be published elsewhere.

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June 27.

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Determination of Elastic Constants from Diffuse Reflexion of X-Rays

Elastic constants of crystals may be determined from measurements of diffuse X-ray reflexions given by them. According to the theory of Waller[1], diffuse reflexions are produced as a result of the superposition of thermal waves (into which the random thermal vibrations of atoms in the crystal can be resolved) on the ideal Bravais lattice. This dynamic stratification makes possible reflexion at angles other than the Bragg setting. The diffuse reflexion at a particular angle of incidence and of reflexion is produced by thermal waves having a definite wavelength and orientation, and from its intensity the frequency of the wave can be calculated. Combining the two data, the velocity of the wave can be obtained and, assuming that there is no dispersion of acoustical velocity, the elastic constants can be calculated from the velocities of waves propagated in different directions.

The apparatus used consists of a spectrometer[2], which is provided with a new design of bent crystal monochromator[3]. Copper $K\alpha$ radiation is invariably used, and the detector for X-rays is a Geiger–Müller counter. Since the diffuse flux observed is in general of the same order as the natural background of the Geiger–Müller counter, an electronic device, named 'background reducer'[4], is used to cut the background down by a factor of three.

The procedure consists in making observations of the diffuse flux at settings corresponding to various chosen points in reciprocal space. The measurements of absolute intensities of diffuse reflexion are accurate only to 15 per cent, although relative values of diffuse flux for different settings are accurate to about 3–5 per cent. Various corrections arising from the conditions of the experiment have to be made to reduce measured diffuse fluxes to standard values for comparison with theory.

Theory shows that, for points in reciprocal space close to a reciprocal lattice point *hkl* and lying on a particular line passing through it, the intensity of diffuse reflexion varies inversely as the square of the distance from the point *hkl*. The name 'rekha' (Sanskrit = ray, pronounced *rékha*) is proposed for such a line in reciprocal space passing through a reciprocal lattice point. A rekha, $[ABC]_{hkl}$, is defined by six parameters A, B, C, h, k, l, where A, B, C are proportional to the direction cosines referred to the rectangular system of co-ordinates which is used for defining elastic constants, and *hkl* are the indices of the associated reciprocal lattice point. It can be shown that, for different rekhas having the same indices *hkl*, the diffuse flux is proportional to $K[ABC]_{hkl}/R^2$, and is a function only of the elastic constants of the crystal, the six indices of the rekha and R, which is the distance of the point of observation in reciprocal space from the lattice point *hkl*. The rekha constant can be obtained using the method of Jahn[6]. The above theory relates only to first-order diffuse reflexions from waves belonging to the acoustical branch of the crystal vibration spectrum. Actually, an observation of diffuse reflexion will contain in addition components from Compton scattering, from diffuse reflexion due to optical waves, and from diffuse reflexion of a second order from acoustical waves. A correction can be made for the first two by making observations corresponding to points lying on particular rekhas, since they are constant for different points along it, while the first-order acoustical diffuse reflexion varies as $1/R^2$, as mentioned above. The third component is eliminated by a method of successive approximation.

From measurements of diffuse flux along different rekhas, it is possible to determine ratios of elastic constants. To obtain the absolute values of elastic constants, it is necessary to measure the intensities of diffuse reflexions absolutely. The method described here is quite general. It has been applied to the measurement of elastic constants of five cubic crystals, and leads to the following values in dyne cm.$^{-2}$.

	$c_{11} \times 10^{-11}$	$c_{12} \times 10^{-11}$	$c_{44} \times 10^{-11}$
KBr	3·5	0·56	0·60
KCl	4·0	0·67	0·71
$NaClO_3$	4·8	1·5	1·2
PbS	9·4	3·5	2·4
$C_5H_{12}N$	1·5	0·3	0·7

Potassium chloride and bromide are test cases, and the values obtained agree reasonably well with the ultrasonic measurements[6], the deviation being less than that between static[7] and ultrasonic data. For sodium chlorate, the data of Mason[8] and of Bhagav-

antam and Suryanarayana[9] are confirmed, and those of Voigt[10] shown to be incorrect. The values for lead sulphide do not agree with those of Bhagavantam[11]. The elastic constants of hexamethylene tetramine have been determined for the first time, and it is believed to be the first organic cubic crystal for which elastic constants have been measured.

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Interferometric Examination of Hardness Indentations on Tin

In an earlier communication in *Nature*[1] we have shown that the Vickers pyramid indentation on steel produces a symmetrical distortion surrounding the indentation, this being revealed by multiple-beam interference fringes.

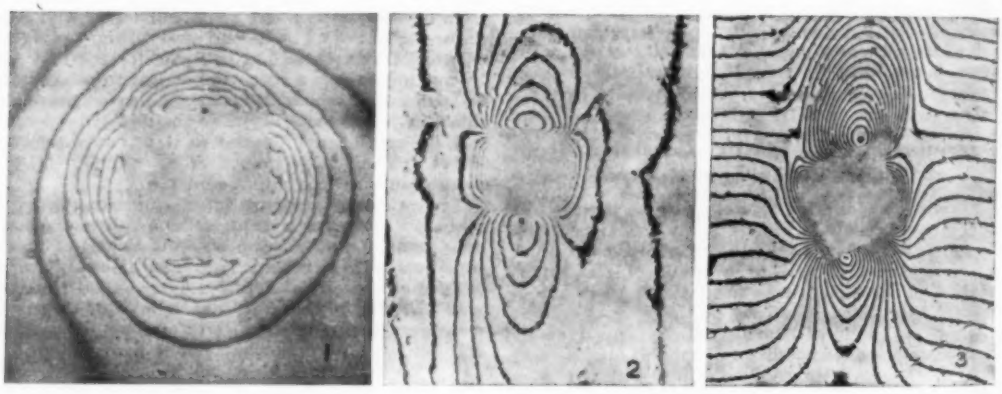
We have applied the same technique to indentations made on 'single crystallites' of tin, with results that are striking. The tin surface was produced by the following method: a piece of good-quality plate-glass was warmed on a hot plate to a temperature slightly exceeding the melting point of tin. A small quantity of tin was melted and poured on to this surface, and the whole allowed to cool. We find that the tin conforms to the surface of the glass and partakes of its natural high polish. The result of this casting is to produce, without any mechanical polish, a perfect state of optical finish, ideally suited to interferometric studies.

A convenient way of removal of the tin from the glass is to make a diamond scratch on the glass immediately behind the tin disk, and on breaking the glass, the tin is released. It is found that the tin shows large areas which are clearly surfaces of 'single crystals', and there is reason to believe, too, that there is some degree of regular crystal orientation. With the aid of a micro-hardness indenter (Vickers pyramid type) indents can be placed within single crystals, and it is found that these lead to surface distortion patterns which are highly asymmetrical. This is best shown by the accompanying photographs. Fig. 1 (× 100) shows a typical symmetrical distortion surrounding the indentation made with a 15 kgm. load on a steel *D.S.En.*22. The high degree of symmetry of the pattern is immediately obvious, and has already been commented upon. Figs. 2 and 3 show the patterns obtained on different tin crystals. In Fig. 2 (× 133), taken with a 50-gm. load, the asymmetry is beautifully shown. It is of interest to note that the extended wings are elevations, the shorter pair being depressions. Opposite the former the indentation sides are convex; opposite the latter, concave. Fig. 3 (magnification × 66) was taken with a 200-gm. load, and, of course, there is a good deal more distortion; but this indentation has been deliberately placed to show that the asymmetry of the distortion is only affected in a secondary manner by the relative positions of the corners and faces, for in Fig. 2 the 'wings' oppose the faces whereas in Fig. 3 they oppose the corners of the indentation.

It is thus quite clear that the asymmetry is a purely crystallographic phenomenon and has nothing to do with the orientation of the square of the indentation.

As a further refinement, attention may be directed to the marked slip or twinning lines in Fig. 3.

We are pursuing these investigations in greater detail, attempting to obtain tin crystals with specified faces of known orientation, on which indentations will be placed.



Since tin has tetragonal structure, the observed asymmetry is not unexpected, and it is our intention to attempt to relate the observations to other crystallographic data.

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Conversion of Mean Solar Time to Mean Sidereal Time

OBSERVATORY practice in the past has always been to use separate clocks for indicating solar and sidereal time. In the case of quartz crystal clocks, this practice could be continued by using two separate crystals, one ground for a frequency of 100 kc./s. and the other for a frequency of 100·273 kc./s. It is, however, much more satisfactory to derive both solar and sidereal second pulses from one standard frequency oscillator. Hitherto, this has been accomplished by means of mechanical gearing, and many efforts have been made towards devising a gear train that would give a good approximation, and which would be mechanically practicable at the same time[1]. A different method is to use gears not for direct conversion, but to drive a continuous phase shifter, which has the effect of increasing one of the standard frequencies by 0·273 per cent[2].

This conversion might with advantage be done by means of electronic divider circuits instead of gears, and the following scheme offers a simple solution to this problem.

A standard frequency of 100 kc./sec. can be divided by numbers M and N which are chosen in such a way that $\left(\frac{100}{M}+\frac{100}{N}\right)$ or $\left(\frac{100}{M}-\frac{100}{N}\right)$ is a close approximation to the desired frequency. For maximum stability of the individual divider stages, it should be possible to break up both M and N into factors not higher than, say, 11.

Two such numbers are 1,155 and 2,744, which give a difference frequency of 50·136,937,892 cycles per second, about 8·5 parts in 10^9 larger than the correct 'sidereal' 50 cycles per second. More elaborate manipulation of such derived frequencies might give a closer approximation; but in practice it is simpler to correct for the error by continuously shifting the phase of one of the frequencies in the divider chain. When such a continuous phase shifter is driven by a synchronous clock motor through suitable gearing, a high order of accuracy may be obtained. For example, running a conventional clock motor, with a 1 r.p.m. shaft, off the 'sidereal' 50 c./s. supply (obtained from the same unit), and using a gear ratio of $\frac{7\times 73}{27\times 71}$ to connect it to a phase shifter at the 9,090·9 c./s. stage, a correction is applied resulting in an output frequency which corresponds to a ratio of 1·002,737,909,294,3. This is the correct ratio for 1,949 within 1 part in 10^{12}. It should be noted that gears only are used for correcting a small residual error. Backlash and tooth errors have a negligible effect on the accuracy of individual second pulses, so that high precision here is unnecessary. Equipment designed along these lines is at present being constructed at the Union Observatory.

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June 25.

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Variance of Triplets

TODD[1] has proposed a series of tests for examining whether the spread of disease in a rectangular plantation of m rows and n columns is random or not. For an observed set s of diseased plants, he compared the expected and observed numbers of doublets formed from these plants, using for the variance of doublets the binomial approximation based on the probability of a single doublet. Todd extended his results to triplets and quadruplets, again using the binomial approximation. Finney[2], however, showed that the binomial approximation over-estimates the variance for doublets, and under-estimates, rather considerably, the variance for triplets and for quadruplets. Krishna Iyer[3] gave the correct expression for the variance of doublets by a characteristically new approach[4]. This note gives the expression for the variance of triplets.

$$\mu_2 = (20b - 28a + 36)\frac{s^{(3)}}{b^{(3)}} + (464b - 842a + 1464)\frac{s^{(4)}}{b^{(4)}} + (2612b - 5972a + 13128)\frac{s^{(5)}}{b^{(5)}} + (400b^2 + 784a^2 - 1120ab - 1656b + 4826a - 13332)\frac{s^{(6)}}{b^{(6)}} - \left[(20b - 28a + 36)\frac{s^{(3)}}{b^{(3)}}\right]^2.$$

If p and $q = 1 - p$ are the probabilities of a plant being diseased and not diseased, the formula works out to be:

$$\mu_2 = (20b - 28a + 36)p^3 + (464b - 842a + 1464)p^4 + (2612b - 5972a + 13128)p^5 - (3096b - 6842a + 14628)p^6,$$

where $b = mn$ and $a = m + n$.

The details of this work are being published in the *Journal of the Indian Society of Agricultural Statistics*.

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May 13.

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Thumb of the Swartkrans Ape-Man

ONE of the most noteworthy differences between man and the higher anthropoids is that while man has a good opposable thumb, in the anthropoid the thumb is somewhat degenerate. It was mainly on this character that Osborn decided that man could not have evolved from an anthropoid.

Though we know the metacarpal of the first finger and a number of phalanges of the Kromdraai ape-man, and the os magnum or capitatum of the Sterkfontein ape-man, we have hitherto had no evidence of the thumb. The known metacarpal is slender and a little longer than in man, while the phalanges are a little shorter. The os magnum of the carpus is similar to that of man and much smaller than that of the higher anthropoids. It was thus manifest that the ape-man hand is essentially human, but remarkably delicate and far too feeble to have been used for walking on.

Above. Right metacarpals of (*a*) *Paranthropus crassidens* and (*b*) Bushman. Natural size. *Below.* End-on views of distal extremities of right metacarpals of (*a*) *P. crassidens* and (*b*) Bushman. Natural size

Fortunately, we now have discovered the thumb metacarpal of the large Swartkrans ape-man. It is almost exactly like that of man, but smaller. There is one important character in which it differs from the human bone. On the inner side of the distal end there is a distinct pointed bony process which presumably divided a pair of large sesamoid bones. In man there is occasionally a small process between the sesamoids; but we have not seen anything at all comparable to the process in this ape-man metacarpal.

The bone, though shorter than in the Bushman, is rather stouter and a little more curved than in man. The metacarpal is less like that of the chimpanzee, and still less like that of the gorilla and orang, where there are usually no sesamoids.

If we assume as probable that the fingers were shorter than in man, we need not be surprised that the thumb is also shorter. As we have evidence of two large sesamoids, it seems likely that the thumb, though a little shorter than in man, was a useful clasping organ, and able to manipulate tools and weapons.

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Sept. 27.

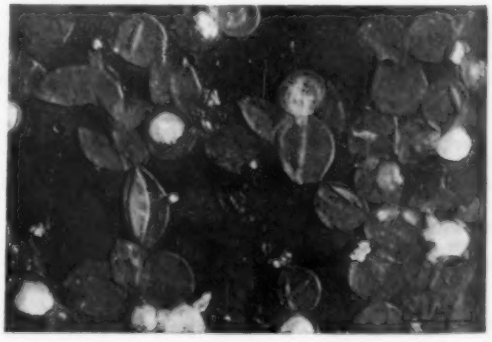
Location of Radioactive Penicillin in *Staphylococcus aureus* after Contact with the Drug

The lethal effect on bacteria of mechanical shaking with very small glass beads has been described by King and Alexander[1]. The morphological picture obtained after subjecting the organisms to such treatment, and the usefulness of the method for producing relatively pure suspensions of cell-wall material, have recently been described[2]. It is possible to count disrupted and intact cells in electron micrographs (see accompanying photograph), and thus determine the percentage of organisms broken down in a given sample. Since the bacterial sample after shaking can be separated in the centrifuge into two fractions, a supernatant consisting of cytoplasmic material from the disrupted cells and a deposit consisting of cell walls and intact cells, the distribution between cell wall and cytoplasm of any system capable of estimation by independent chemical or physical methods can be determined.

The method has been used to determine the distribution of radioactive penicillin between the cell wall and cytoplasm in the case of *Staphylococcus aureus* (*SS* II St. Mary's strain). Cooper and Rowley[3], using a radioactive tracer technique, have already shown that penicillin is removed from low concentrations of the drug by sensitive bacteria, and this small, strongly attached uptake has been shown to be related to its mode of action[4]. Since Gale and Taylor[5] have observed that transport of amino-acids across the osmotic barrier of the bacterial cell is affected by this drug, it is of importance to ascertain whether the drug is to be found attached to the cell wall or inside the bacterium. If the penicillin actually reacted directly with the 'transport' enzymes only, it would be expected that the radioactivity would be found attached to the cell wall.

Sensitive staphylococci were washed twice before and twice after standing for 30 min in a 0·1 c.c./ml. solution of radioactive penicillin. 5-ml. samples containing 10–30 mgm./ml. dry weight of these bacteria were shaken at about forty vibrations a second for one hour on a 'Microid' shaker with 10 gm. of fine glass beads ('ballotini'). The suspension was at once separated into supernatant and deposit fractions in the centrifuge (10 min. at 10,000 g.), and the two fractions were recovered quantitatively and assayed for radioactivity. The temperature was maintained at 6° C. until separation was complete.

The bulk of the sulphate-35 was found in the supernatant liquor, the proportion of the total radioactivity of the system found in this supernatant corresponding exactly with the proportion of bacteria which had been disrupted (see table). As the cell wall of this *Staphylococcus* was found to account for 20 per cent of its dry weight, the only distribution of radioactivity which will fit these figures is that in which all is contained in the cytoplasm, and none is attached to the cell walls. Thus the radioactivity remaining in the impure cell-wall preparation could be entirely accounted for by the disrupted bacteria present.



A typical disrupted preparation of *Staphylococcus aureus* (*SS* II strain). The density of the undisrupted and partially lysed organisms as compared with that of the free cell-wall material is apparent. The preparation has been shadow-cast with palladium. Scale in lower right-hand corner

Correlation between percentage breakdown of cells (calculated from electron microscopic counts of cell walls and whole bacteria in the deposit) and the proportion of the total radioactivity found in the supernatant

Sample	Proportion of cells disrupted (per cent)	Proportion of total radioactivity in supernatant (per cent)
1	92 ± 2	93 ± 5
2	60 ± 2	59 ± 5
3	92 ± 2	92 ± 5

Assuming that penicillin remains firmly bound to its site of attachment during the time required for these experiments, as has been shown to be the case with intact bacteria[4], these results show that the penicillin is concentrated within the cytoplasm of the cell of this typically sensitive organism.

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Anti-Hæmolytic Effects of Vitamin C

The possibility of inhibition of hæmolysis *in vitro* has interested many workers. The anti-hæmolytic effects, *in vitro*, of substances such as sucrose, cholesterol[1–3], phospholipins[4], plasma proteins[5,7] have been repeatedly examined. The inhibitor effect of these substances has been shown on hæmolysis due to different kind of lysins such as saponin, bile salts, oleate, lysolipins, streptolysin, but not, so far as I know, on hæmolysis due to complement. My experiments deal with this latter type of hæmolysis and with hæmolysis due to saponin. The red cells used have been red sheep cells. The inhibitor substance used has been vitamin C (Roche) in vials of 1 c.c. with a *p*H of 6·5; each vial contained 100 mgm. of vitamin C.

The hæmolytic system I used is the same as in the Wasserman test. The first set of twelve tubes, used as controls, were each filled with 1·6 c.c. of saline solution, and 0·3 c.c. of complement (fresh serum of guinea pig diluted 1 : 7), 1 c.c. of sheep red cells (5 per cent suspension), and 0·5 c.c. of amboceptor (dilution 1 : 2,000 of amboceptor of titre 1 : 4,000).

A second set of tubes were each filled with 1·3 c.c. of saline solution and 0·3 c.c. of vitamin C and 1 c.c. of red sheep cells (5 per cent suspension). These tubes were left at room temperature for 10 min. and then mixed with 0·3 c.c. of complement (diluted 1 : 7) and 0·5 c.c. of amboceptor (dilution 1 : 2,000 of an amboceptor of titre 1 : 4,000).

The two series of tubes were placed in an incubator at 37° C. for one hour. After 1, 12 and 24 hr. the following observations were made:

	After 1 hr.	After 12 hr.	After 24 hr.
Hæmolysis in the 12 tubes without vitamin C	++	++	++
Hæmolysis in the 12 tubes with vitamin C	—	—	—

These results show clearly an effective anti-hæmolytic action of the vitamin C in the system amboceptor, complement, red cells. In order to see whether or not the dilution of the complement and of the amboceptor could interfere with the phenomena mentioned, the same experiments were repeated with the amboceptor and the complement at a smaller dilution. Again a set of twelve tubes, used as controls, were each filled this time with 1·6 c.c. of saline solution and 0·5 c.c. of complement (fresh serum of guinea pig diluted 1 : 5) and 0·5 c.c. of sheep cells (5 per cent suspension) and 0·5 c.c. of amboceptor (dilution 1 : 1,000 of an amboceptor of titre 1 : 4,000).

A second set of tubes were each filled with 1·3 c.c. of saline solution, 0·3 c.c. of vitamin C (10 per cent) and 0·5 c.c. of sheep red cells. These tubes were left at room temperature for 10 min. and then 0·5 c.c. of complement (1 : 5) and 0·5 c.c. of amboceptor (1 : 1,000 of an amboceptor of titre 1 : 4,000) were added. The two sets of tubes were placed in an incubator at 37° C. for one hour. After 1, 12 and 24 hr. the following observations were made:

	After 1 hr.	After 12 hr.	After 24 hr.
Hæmolysis in the 12 tubes without vitamin C	+++	+++	+++
Hæmolysis in the 12 tubes with vitamin C	—	—	—

These results reveal that in spite of decreasing the dilution of the complement and of the amboceptor, the anti-hæmolytic action of the vitamin C still persists. Also the antihæmolytic effect is always constant and complete. It is difficult to explain the mechanism of this anti-hæmolytic effect. According to Ponder, in any inhibition of hæmolysis three hypotheses have to be considered. The inhibitor may react irreversibly with the components of the red-cell surface. In this case the inhibiting effects would persist after the inhibitor has been allowed to remain in contact with the cells for some time, at the end of which it is washed off. The inhibitor may cause a reduction of concentration of the lysin on the cell surface; in this case the inhibitor effect would not persist after the inhibitor has been washed away. The lysin may react with the lysin in the bulk phase of the system, rendering the latter inert. In this case the red cells added would act merely as an indicator of the amount of lysin present, the quantity of which may be shown to vary in some cases with the temperature at which the inhibitor and lysin are mixed[8].

To see whether or not the first of these possibilities could be considered in this case, I carried out the following experiment. The first set of twelve tubes were each filled with 0·4 c.c. of vitamin C (10 per cent) and 0·6 c.c. of sheep red cells (5 per cent suspension) and then left at room temperature for 15 min. At the end of that time the contents of each of these tubes were centrifuged and washed with saline solution twice. A second set of twelve tubes received the same treatment as the first set, except that the contents of these tubes were centrifuged and washed with saline five times. Then I added 0·5 c.c. of complement (1 : 5) and 0·5 c.c. of amboceptor (dilution 1 : 2,000 of an amboceptor of titre 1 : 4,000) to each tube of both sets (the washed red cells of which were diluted in 0·1 c.c. of saline), and placed them in an incubator at 37° C. for one hour. After 1, 12 and 24 hr. the following observations were made:

	After 1 hr.	After 12 hr.	After 24 hr.
Hæmolysis in tubes with washed twice red cells	±	±	±
Hæmolysis in tubes with red cells washed five times	++	+++	+++

These results show that the vitamin C probably acts on the red cells and the action is not irreversible, although it is not an easily reversible one. In order to see if this supposed protective action might be aspecific, I examined hæmolysis due to saponin.

A first set of five tubes were each filled with saline, saponin and sheep cells (red) in the following manner :

Tube	1	2	3	4	5
Saline	0·2 c.c.	0·3 c.c.	0·4 c.c.	0·5 c.c.	0·6 c.c.
Saponin (0·05%)	0·5	0·4	0·3	0·2	0·1
Sheep red cells (3%)	1	1	1	1	1

These tubes were used as controls.

A second set of five tubes were each filled with vitamin C and sheep red cells and were allowed to remain in contact, at room temperature, for 15 min. Then saponin was added. The quantities are listed below.

Tube	1	2	3	4	5
Vitamin C	0·2 c.c.	0·2 c.c.	0·2 c.c.	0·2 c.c.	0·2 c.c.
Sheep red cells (3%)	1	1	1	1	1
Saline	0	0·1	0·2	0·3	0·4
Saponin (0·05%)	0·5	0·4	0·3	0·2	0·1

All of the tubes of both series were left at room temperature, and after two hours the following observations were made.

	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5
Hæmolysis in the tubes without ascorbic acid	+++	++	++	+	∓
Hæmolysis in the tubes with vitamin C	±	−	−	−	−

The same experiments were repeated three times with the same results.

These results show also in this case a clear anti-hæmolytic action of the vitamin C.

Thus the anti-hæmolytic effect *in vitro* of vitamin C on hæmolysis due to the complement and the saponin has been shown. How this anti-hæmolytic action takes place, it is now difficult to say ; it is my personal feeling that the strong reducing power of the vitamin C might account for it.

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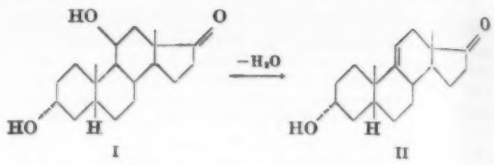
Isolation of 11-Hydroxy-etiocholanol-3(α)-one-17 from the Urine of Male Patients with Adrenal Cancer

A SUBSTANCE that proved to be Δ9-etiocholenol-3(α)-one-17 (II) was isolated by Lieberman *et al.*[1] from the urine of certain patients with cancer of the breast or prostate, lymphatic leukæmia, essential hypertension or Cushing's syndrome. They suggested that Δ9-etiocholenol-3(α)-one-17 was a derivative of 11-hydroxy-etiocholanol-3(α)-one-17 (I) and was formed from the latter compound by dehydration during the acid hydrolysis of the urine. Later, they were able to identify (I) in urinary extracts by infra-red spectroscopy[2].

We have now been able to isolate 11-hydroxy-etiocholanol-3(α)-one-17 from the urine of two male patients with adrenal cancer.



I II

From the first patient, aged twenty-two years, who developed a typical Cushing's syndrome, about twenty litres of urine were collected. The urine was hydrolysed and extracted by the method of Dingemanse and Laqueur[3]. The extract was fractionated on chromatographic columns by the method of Dingemanse *et al.*[4].

A compound giving Zimmermann's reaction for 17-ketosteroids was eluted with benzene containing 0·5 per cent of ethanol. After repeated crystallization from aqueous ethanol, a substance with m.p. 237–238° C. was obtained. Further recrystallization did not change this melting point. (The melting point of 11-hydroxy-etiocholanol-3(α)-one-17, according to Sarett[5], is 238·5–240·5° C.)

As only a few milligrams of the substance could be isolated in a pure state, no analysis could be made. An acetate with m.p. 215–222° C. was prepared with acetic anhydride in pyridine solution. The amount of substance isolated was too small to allow further recrystallization. (The melting point of 11-hydroxy-etiocholanol-3(α)-one-17-acetate, according to Sarett[5], is 237–238° C.)

Eight litres of urine were then collected from a second patient, a male aged eighteen years, who was suffering from an adrenal cancer and developed an atypical Cushing's syndrome. About 8 mgm. of a 17-ketosteroid with m.p. 237–238° C. was obtained. An acetate with m.p. 238–238·5° C. was prepared ($C_{21}H_{32}O_4$ requires C, 72·35 ; H, 9·27 ; found, C, 71·78 ; H, 9·08).

According to these data the substance isolated from the urinary extracts was 11-hydroxy-etiocholanol-3(α)-one-17.

The quantitative analyses were carried out by Mr. P. Hubers in the Laboratory for Organic Chemistry of the Amsterdam Municipal University. A grant for this study was received from Organon, Ltd., Oss.

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Fate of N-Methylnicotinamide in Man

FOLLOWING the discovery that N-methylnicotinamide is a metabolite of nicotinic acid[1], the fate of this compound in the animal body has been studied by several workers. Perlzweig and Huff[2] found that only 10–20 per cent of a dose of N-methylnicotinamide administered orally to human beings could be recovered in the urine, and concluded that N-methylnicotinamide is not the final metabolite of nicotinic acid, but is further metabolized into unidentified products. Ellinger[3] studied the faecal excretion of N-methylnicotinamide by the rat and discovered that

After the ingestion of N-methylnicotinamide the faecal output of this compound was sometimes increased and sometimes not; on no occasion was more than 10 per cent of a dose recovered in the faeces. Ellinger showed that N-methylnicotinamide is destroyed when incubated with rat faeces. He also demonstrated that N-methylnicotinamide is present in rat bile, and he suggested that the portion of a dose of N-methylnicotinamide which is not recovered in the urine and in the faeces may be eliminated with the bile into the intestines and there destroyed by the intestinal flora.

The recent discovery that N-methylnicotinamide is converted in the liver of man or of the rabbit into N-methyl-2-pyridone-5-carboxylamide[4,5] suggests that at least a part of the N-methylnicotinamide previously unaccounted for may be converted into the pyridone. Since a colorimetric method for the estimation of the pyridone in urine is now available, and since the urinary excretion of the pyridone has been shown to account for 47–57 per cent of a dose of nicotinamide[6], it was decided to ascertain what proportion of a dose of N-methylnicotinamide is converted into the pyridone in the human body.

The urinary excretion of various metabolites of nicotinic acid, including the pyridone, by two adult European subjects (No. 1 a male of 27 years, No. 2 a female of 36 years) was studied over successive 24-hr. periods before and after the ingestion of a dose of 500 mgm. of N-methylnicotinamide chloride. The results (Table 1) show that only 7–11 per cent of the dose could be accounted for in the urine as N-methylnicotinamide, and 11–12 per cent as N-methyl-2-pyridone-5-carboxylamide; only 18–24 per cent of the dose could be accounted for in the form of all the known metabolites of nicotinic acid. This experiment was, however, of relatively short duration.

Table 1. Urinary excretion of various metabolites of nicotinic acid before and after oral administration of 500 mgm. of N-methylnicotinamide chloride

Subject No.	Derivative of nicotinic acid	Urinary excretion (mgm. per day)			% of dose excreted in the urine
		Before dose	After dose		
		Day 1	Day 1	Day 2	
1	Total acid-hydrolysable derivatives	2·8	2·9	3·7	1
	N-methylnicotinamide	4·7	33·5	18·6	11
	N-methyl-2-pyridone-5-carboxylamide	15·2	57·7	25·8	12
					Total 24
2	Total acid-hydrolysable derivatives	0·9	0·6	0·4	0
	N-methylnicotinamide	6·7	33·8	6·3	7
	N-methyl-2-pyridone-5-carboxylamide	9·9	50·9	19·0	11
					Total 18

In a second experiment, the urinary excretion of the pyridone and of other metabolites of nicotinic acid by a third subject (a healthy male European of 34 years) was determined during a preliminary period of seven days, and then in an experimental period of seven days during which doses of 500 mgm. of N-methylnicotinamide chloride were ingested on the second, third and fourth days. The results (Table 2) show that only 20 per cent of the total dose (1,500 mgm.) could be accounted for in the urine as N-methylnicotinamide, and 19 per cent as N-methyl-2-pyridone-5-carboxylamide.

Table 2. Urinary excretion of various metabolites of nicotinic acid before and after oral administration of 1,500 mgm. of N-methylnicotinamide chloride

Derivative of nicotinic acid	Urinary excretion (mgm. per week)		% of dose excreted in the urine
	Preliminary period	Experimental period	
Total acid-hydrolysable derivatives	19·2	20·2	0·1
N-methylnicotinamide	63·9	304·1	20
N-methyl-2-pyridone-5-carboxylamide	102·5	356·0	19
			Total 39

Since the possibility exists that the pyridone may be excreted in the faeces, the stools were collected during both the preliminary and experimental periods, and centrifuged aqueous extracts were prepared and analysed by the method previously described. No trace of N-methyl-2-pyridone-5-carboxylamide could be detected in the faeces either in the preliminary period or after the ingestion of N-methylnicotinamide.

The present results show that only a small proportion of the missing N-methylnicotinamide can be accounted for as the pyridone. It must therefore be concluded that the remaining N-methylnicotinamide is destroyed or further metabolized. The former possibility is reasonable, since ring fission may be expected to occur readily in a pyridinium compound.

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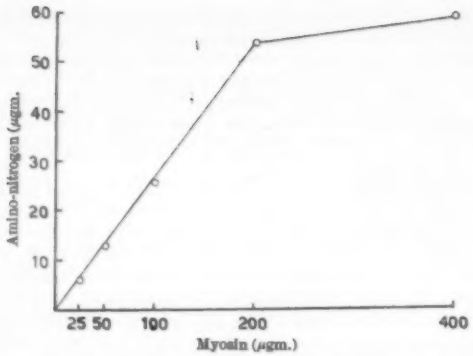
Myosin as Adenylic Acid Deaminase

Schmidt[1] was the first to describe the preparation of an extract from rabbit muscle which specifically deaminates adenosine-5-phosphoric acid. When adenosinetriphosphate was identified from muscle, Lohmann and Schuster[2] observed that Schmidt's deaminase often deaminates adenosinetriphosphate. They modified Schmidt's procedure to obtain an extract which, according to them, deaminates adenylic acid only. Recently, Kalckar[3] has isolated adenylic acid deaminase from water extract and from myosin preparations of rabbit muscle.

We have observed that actin-free myosin from rabbit muscle, crystallized according to Szent-Györgyi[4], is a very active deaminase preparation, even after three recrystallizations. The deaminase activity of crystalline myosin is as great or greater than that of the preparations cited above. We were able to show that in all these preparations the presence of myosin is responsible for the deaminase activity.

The activity of crystalline myosin as a function of enzyme concentration is shown in the accompanying graph. Its activity is expressed in terms of Q_N = 4,400–5,800, at the *p*H optimum 5·9–6·1.



Ammonia production from adenylic acid in presence of varying amounts of myosin. Each sample contained 0·1 *M* potassium chloride, 0·1 *M* succinate buffer *p*H 5·9 and 1·5 mgm. adenylic acid (containing 60 μgm. amino-nitrogen). Incubation: 5 min. at 30°

The activity of Schmidt deaminase prepared according to Lohmann and Schuster[2] was found to be the same as that of myosin. We have been able to show that the protein component of Schmidt deaminase is myosin, on the following grounds: (1) salt fractionation and solubility tests; (2) when used in higher concentration it shows adenosinetriphosphatase and adenosinediphosphatase activity (it contains a trace of myokinase); (3) when actin is added to the Schmidt deaminase, actomyosin is formed, that is, in 0·5 *M* potassium chloride its viscosity rises, and this rise can be reduced by the addition of adenosinetriphosphate. Because of the very different treatments used for the preparation of Schmidt deaminase and crystalline myosin, all these properties could not be compared on a quantitative basis.

Similar observations were made with the deaminase prepared according to Kalckar[3]. (1) Although this preparation starts from a water extract, it is known that simple extraction with water dissolves some myosin, and Kalckar's deaminase has no higher activity than myosin; (2) when crystalline myosin is dialysed against 0·02 *M* ammonium acetate at *p*H 8, the activity of the soluble fraction is not greater than that of myosin. This is the procedure employed by Kalckar to prepare a deaminase from Bailey's myosin[5]. Bailey's myosin is a less active deaminase than crystalline myosin, probably because it is less soluble in dilute salt solutions than myosin. The highest activity observed by Kalckar is $Q_N = 4{,}000$, not more than that observed with crystalline myosin.

It has already been noted by others[6,7] that myosin deaminates adenylic acid. Our investigations have shown that adenylic acid deaminase is bound to the myosin fraction as strongly as adenosinetriphosphatase. No treatment could be devised which would separate the deaminase from myosin. The activities of myosin as adenosinetriphosphatase (highest activity observed $Q_P = 8{,}000$; cf. Engelhardt[8]) and as deaminase ($Q_N = 5{,}800$, our observation) are of the same order of magnitude.

As crystalline myosin has high activity as deaminase, this explains the production of ammonia observed during the dephosphorylation of adenosinetriphosphate. Banga[9], using crystalline myosin, has shown that, in presence of a water-soluble extract, deamination occurs when the second phosphate is split off from adenosinetriphosphate. Myosin splits off one phosphate from adenosinetriphosphate, adenosinediphosphate is changed to adenosinetriphosphate and adenylic acid through the action of myokinase present in the water extract. When myosin dephosphorylates the adenosinetriphosphate thus produced, it deaminates an equivalent amount of adenylic acid. The apparent deamination of adenosinediphosphate requires no separate enzyme, but only the specific adenylic acid deaminase, crystalline myosin itself.

Kalckar and Rittenberg[10] have shown that the exchange of adenosinetriphosphate-nitrogen proceeds at a high rate, and the exchange can be traced nearly exclusively to the 6-amino-nitrogen of adenosinetriphosphate. There is thus a constant rejuvenation of adenosinetriphosphate-amino-nitrogen.

As adenylic acid deaminase is equally active and bound in the same way to myosin as adenosinetriphosphatase, and the amino-nitrogen of adenosinetriphosphate is rejuvenated at a high rate, adenylic acid deaminase may have the same importance in muscle contraction as adenosinetriphosphatase.

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June 3.

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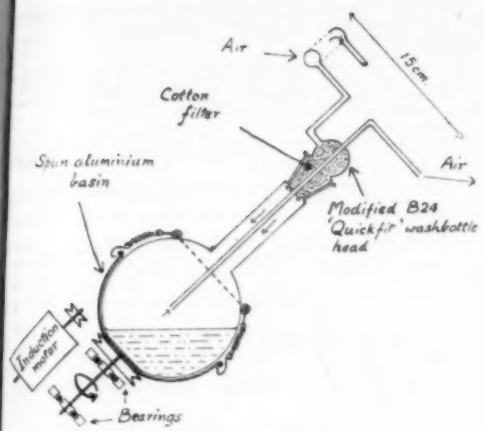
A New Technique for Stirred Aerated Culture

In the course of work on the growth characteristics of *Staph. aureus*, stirring and aeration of cultures was required to provide standard favourable growth conditions. The usual method of bubbling with a stream of sterile compressed air is technically rather unsatisfactory, and a new culture technique has consequently been devised.

The requirements were that the culture vessel should be a separate unit which can be handled as readily as a plugged flask; that it should eliminate the difficulties of sterilization and frothing which accompany the use of compressed air; and that no troublesome moving parts such as stirring rods should be introduced into the sterile system. The method evolved is illustrated in the accompanying diagram. A 1-litre 'Quickfit' flask containing up to 400 ml. of medium is rotated about its axis, tilted at 45° to the vertical, at 3 rev. per second. The rotation gives efficient stirring and at the same time causes the air of the temperature-controlled room to be exchanged with the air above the medium through the cotton filter inside the 'Quickfit' head. When the filter is not too tightly packed, the air is exchanged at about 20 ml. per minute, and tests with sterile medium show that contamination does not occur during continuous running for 30 hr. at 25° or 37° C.

This type of unit has been in use for more than two years, and has been found to give growth curves of good reproducibility.



It has also been observed that, while the growth of *Staph. aureus* on a casein digest medium containing 'Marmite' and 1 per cent glucose in Roux bottles gives a crop in the stationary phase of rather less than 1 mgm. per ml. (16 hr. growth with a heavy inoculum, at 37° C.), growth in the rotated flask gives a crop of about 3 mgm. per ml. The rotated flask method has consequently been adapted for routine growth in place of Roux bottles, using 5-litre flasks, fitted with appropriate air exchange heads, containing 2 litres of medium. In one of these flasks, the same growth may be obtained as from thirty Roux bottles.

For operation outside the hot room, the device is housed in a small incubator through the sloping side of which the neck of the rotating flask is allowed to project.

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June 9.

The Teleostean Swimbladder and Vertical Migration

IT has been suggested by several authors[1–6] that the vertical movements of a teleost would be restricted by the presence of a swimbladder which will increase or decrease in volume when the fish moves up or down in the water. Fishes taken by line or trawl often arrive at the surface visibly distended, when they are said to be 'blown'. If they are taken from deep water the enlargement of the bladder may lead to the eversion of the stomach through the mouth or to the rupture of the bladder wall. This is well known to fishermen and has been an obstacle in fishery research, for example, in marking experiments on cod[7] and in the analysis of the stomach contents of hake taken from deep water[8]. But little appears to be known about the extent to which the swimbladder restricts vertical migration.

Since the problem is easier to study in freshwater than in marine teleosts, observations have been made on the perch (*Perca fluviatilis* Linn.) living in Windermere. In the late spring and early summer the fishes migrate into shallow water to spawn[9] and can be trapped in large numbers at depths ranging from 60 to 15 ft. Traps were set at different depths and hauled rapidly to the surface and the fishes opened up to see if the bladders were intact. The results are set out in the accompanying table, from which it will be seen that more than 80 per cent of the females taken from a depth of 45 ft. or more were found to have broken bladders. Only 14 per cent of those taken from 30 ft. had broken bladders, while all those taken from 15 ft. were found to have their bladders intact. The results for the males were slightly different, and a possible reason for this is given below.

Relation between the depth at which the perch were trapped and the percentage of the catch with broken bladders

Depth of the trap		60	45	30	15 ft.
Percentage of the catch with broken bladders	Males	97	93	61	1
	Females	93	80	14	0

At a depth of 45 ft., the perch are living under a pressure of 2½ atmospheres, and the results show that when a perch is suddenly hauled to the surface from this depth the swimbladder will generally burst. If a perch is adapted to a depth of 45 ft., it will undergo a pressure reduction of three-fifths when hauled to the surface, and laboratory experiments have shown that in both sexes the bladder bursts when the total pressure to which the fish is adapted is reduced by this proportion. It would therefore be expected that the results of the trapping experiments would be the same for males and females. A possible explanation of the anomalies in the results is that some of the fishes in the traps had recently come from shallower or deeper water and in consequence were not adapted to the depth at which they were caught when hauled to the surface. But it is beyond the scope of this note to discuss this point any further.

The distance that a perch can migrate rapidly upwards before there is any danger of the bladder rupturing will, therefore, depend on the depth to which the fish is adapted. At a depth of 120 ft. the fish will be under a pressure of 4 atmospheres, and a pressure reduction of three-fifths will permit an upwards movement of 90 ft. before any danger is encountered. But the same proportional pressure reduction will only allow a fish adapted to 60 ft.—and thus under a pressure of 3 atmospheres—to swim up for 54 ft.

The bladder wall of the perch is thin and delicate, and it remains to be seen how far these conclusions apply to fishes such as the cod and the hake, which have thick-walled swimbladders.

Experiments have been made on the behaviour of the perch to changes of hydrostatic pressure, and on the speed with which it can adjust the gas content of the swimbladder when subjected to a reduction of pressure. From these and other experiments it should be possible to describe in a more precise way the limitations that the swimbladder imposes on vertical movements.

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June 8.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 14

INSTITUTION OF OFFICE MANAGERS, WEST MIDLAND BRANCH (at the Grand Hotel, Birmingham), at 12.30 p.m.—Mr. W. Higgs: "The Psychology of Works Management".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. E. Ashby: "Hybrid Vigour in Plants" (Clayton Memorial Lecture).*

UNIVERSITY OF LONDON (in the Department of Electrical Engineering, King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. J. Greig: "John Hopkinson, 1849–1898" (Hopkinson Centenary Lecture).*

INSTITUTE OF PHYSICS, MIDLAND BRANCH (joint meeting with the INSTITUTION OF THE RUBBER INDUSTRY, at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 7 p.m.—Papers on "Behaviour of Rubbers at Low Temperatures".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, London, W.C.2), at 7 p.m.—Mr. B. S. Gossling: "The Dependence of Physics on the Engineer" (Students' Lecture).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—M. Paul-Emile Victor: "French Explorations in Central Greenland".

Tuesday, November 15

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. P. Denes: "New Techniques in the Measurement of Hearing".*

UNIVERSITY OF LONDON (at the Royal Veterinary College, Royal College Street, London, N.W.1), at 4 p.m.—Prof. R. A. Kelser: "Adaptation of Viruses to Different Host Species and Different Tissues".*

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. David Jones: "Family Service Units for Problem Families".*

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. G. Bradfield: "The Generation and Launching of Ultra-Sonic Waves".

ROYAL AERONAUTICAL SOCIETY, GRADUATE AND STUDENT SECTION (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr. A. D. Young: "Visualisation of Air Flow at High Speeds".

Wednesday, November 16

INSTITUTE OF METALS AND ASSOCIATED SOCIETIES (at the Royal Institution, Albemarle Street, London, W.1), at 10 a.m.—Symposium on "Metallurgical Applications of the Electron Microscope".

UNIVERSITY OF LONDON (at the Royal Veterinary College, Royal College Street, London, N.W.1), at 4 p.m.—Prof. R. A. Kelser: "Foot-and-Mouth Disease, with Special Reference to Important Facts and Problems Emphasized by the Current Outbreak in Mexico".*

CHEMICAL SOCIETY, LIVERPOOL SECTION (in the Chemistry Lecture Theatre, The University, Liverpool), at 4.30 p.m.—Dr. M. Magat: "Radiation Induced Polymerization" (Centenary Lecture).

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Mr. T. W. Kent: "The Welfare Economy".

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Mr. J. Grunberg: "The Oxyton Cycle in the Production of Tonnage Oxygen".*

INSTITUTION OF ELECTRICAL ENGINEERS, SHEFFIELD SUB-CENTRE (at the Grand Hotel, Sheffield), at 6.15 p.m.—Discussion on "Industrial Heating".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Royal Society of Medicine, Wimpole Street, London, W.1), at 6.30 p.m.—Annual General Meeting.

SCIENTIFIC FILM ASSOCIATION (at the Wellcome Foundation Institute, 183 Euston Road, London, N.W.1), at 7 p.m.—Symposium on "Problems in making Psychological Films".

Thursday, November 17

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. D. M. Ross: "Animals without Locomotion".*

UNIVERSITY OF LONDON (at the Royal Veterinary College, Royal College Street, London, N.W.1), at 4 p.m.—Prof. R. A. Kelser: "Rabies and its Control".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Special General Meeting to consider the Annual Report of Council; Mr. E. Baldwin and Mr. W. H. Yudkin: "Phosphagen in the Annelida"; Mr. L. H. Matthews: "Reproduction in the Basking Shark".

BRITISH GLACIOLOGICAL SOCIETY (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 4.45 p.m.—Annual General Meeting: Mr. G. Seligman: Survey of his Glaciological Investigations in Switzerland during 1949; Mr. Douglas Mason: "The Larsen Shelf Ice, Weddell Sea".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. W. V. D. Hodge: "Some Recent Developments in the Theory of Algebraic Varieties" (Presidential Address).

INSTITUTE OF PHYSICS (joint meeting of the INSTITUTION OF ELECTRICAL ENGINEERS and the EDUCATION GROUP, at the Institution of Electrical Engineers, Savoy Place, London, W.C.1), at 5.30 p.m.—Discussion on "The Education and Training of Technologists".

INSTITUTION OF STRUCTURAL ENGINEERS, LANCASHIRE AND CHESHIRE BRANCH (at the College of Technology, Manchester), at 7 p.m.—Mr. W. G. Carter: "The Use of Plastic Models in Designing Modern Structures".

CHEMICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 7.15 p.m.—Dr. M. Magat (Paris): "Radiation Induced Polymerization" (Centenary Lecture).

TEXTILE INSTITUTE (joint meeting with the PHYSICAL SOCIETY and LOCAL SECTIONS of the SOCIETY OF DYERS AND COLOURISTS and the SOCIETY OF CHEMICAL INDUSTRY, at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Dr. F. Happey: "A New Approach to the Problem of the Structure of Cellulose and its Derivatives".

Thursday, November 17—Friday, November 18

BRITISH INSTITUTE OF RADIOLOGY (joint meetings with the ROYAL SOCIETY OF MEDICINE, at 32 Welbeck Street, London, W.1), at 8.15 p.m.—"Chemical Factors Modifying Radiobiological and Radiotherapeutic Response".

Friday, November 18

PHYSICAL SOCIETY, OPTICAL GROUP (in the Small Physics Theatre of Imperial College, Imperial Institute Road, London, S.W.7), at 3.30 p.m.—Scientific Papers.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5 p.m.—Wing-Comdr. E. Anderson: "Navigation in High Speed Flight".

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. A. J. Guinier: "Sur la Structure Mosaique des Cristaux"; Mr. C. Balakrishnan and Dr. J. D. Craggs: "On the Velocity of Discharge Propagation in Externally-quenched Geiger Counters"; Mr. B. Collinge: "Dead Times of Self-quenching Counters".

CHEMICAL SOCIETY, SOUTH WALES BRANCH (joint meeting with the UNIVERSITY COLLEGE STUDENTS' CHEMICAL SOCIETY, at University College, Swansea), at 5.30 p.m.—Prof. M. G. Evans, F.R.S.: "The Formation and Reactions of Free Radicals in Solution".

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Mr. B. N. Watts: "The Application of Infra-Red Detectors".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. D. M. S. Watson, F.R.S.: "Africa and the Origin of Man".

Saturday, November 19

INSTITUTION OF OFFICE MANAGERS, SHEFFIELD BRANCH (at the Royal Victoria Station Hotel, Sheffield), at 3 p.m.—Discussion on "Recruitment for Management—University Training versus Shop-floor Experience".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ENGINEER III, at a Ministry of Supply Establishment in Kent—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.364/49/BN (November 19).

LECTURESHIP AND A DEMONSTRATORSHIP IN PHARMACOLOGY—The Registrar, The University, Leeds 2 (November 21).

LECTURESHIP IN ENGINEERING OR A PROBATIONARY ASSISTANT LECTURESHIP IN ENGINEERING—The Registrar, University College, Singleton Park, Swansea (November 23).

ASSISTANT LECTURESHIP IN MATHEMATICS—The Registrar, The University, Reading (November 24).

LECTURER IN SOCIAL CASE WORK in the Department of Social Studies, University of Sydney—The Secretary, The Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 26).

OFFICER-IN-CHARGE, Textile Research Laboratory of the Commonwealth Scientific and Industrial Research Organisation, Geelong—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, referring to appointment No. 2492 (December 10).

RESEARCH BURSARIES (2) tenable in the Department of Technology, University of Sheffield—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Plant Engineering Division".

LECTURER IN THE RADIO FREQUENCY SECTION and a LECTURER IN THE AUDIO FREQUENCY SECTION of the Engineering Training Department at Evesham—The Engineering Establishment Officer, B.B.C., Broadcasting House, London, W.1.

ENTOMOLOGIST to conduct entomological surveys in the areas selected for development in the Volta River basin, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27215/230.

LECTURER IN CHEMISTRY (including Biochemistry) required for the School of Chemistry and Pharmacy, Royal Medical College, Baghdad—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 quoting M/N/22783/3F.